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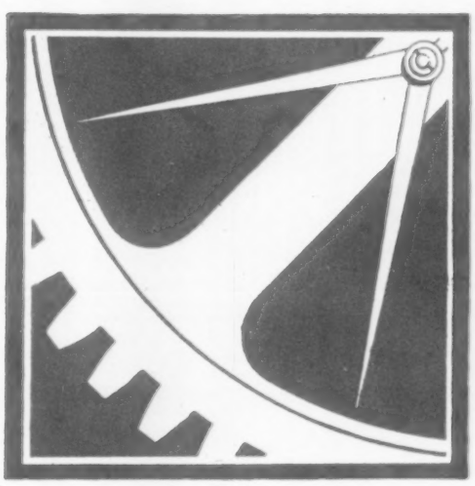
MACHINE DESIGN



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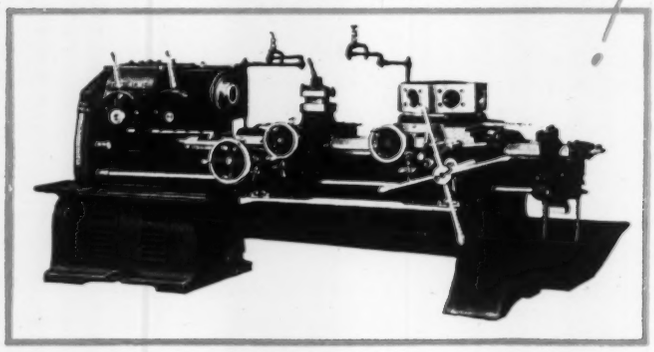

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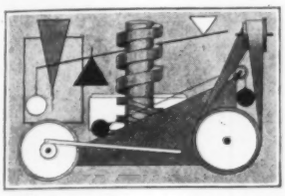
Volume 2 | May, 1930 | Number 5



Next MONTH

SCHEDULED to appear in next month's number is the article by F. V. Hartman on the employment of wrought aluminum alloys in design. This contains a fund of interesting and valuable information, bringing to light many of the lesser known applications of aluminum in this more recently developed form.

Transmission of power to or within machines, a subject of primary importance in design work, forms the basis for a series of articles which will appear in future issues from time to time. These will be prepared specifically from the standpoint of design by authorities in the field of power transmission.

L. E. Jermy.

Managing Editor

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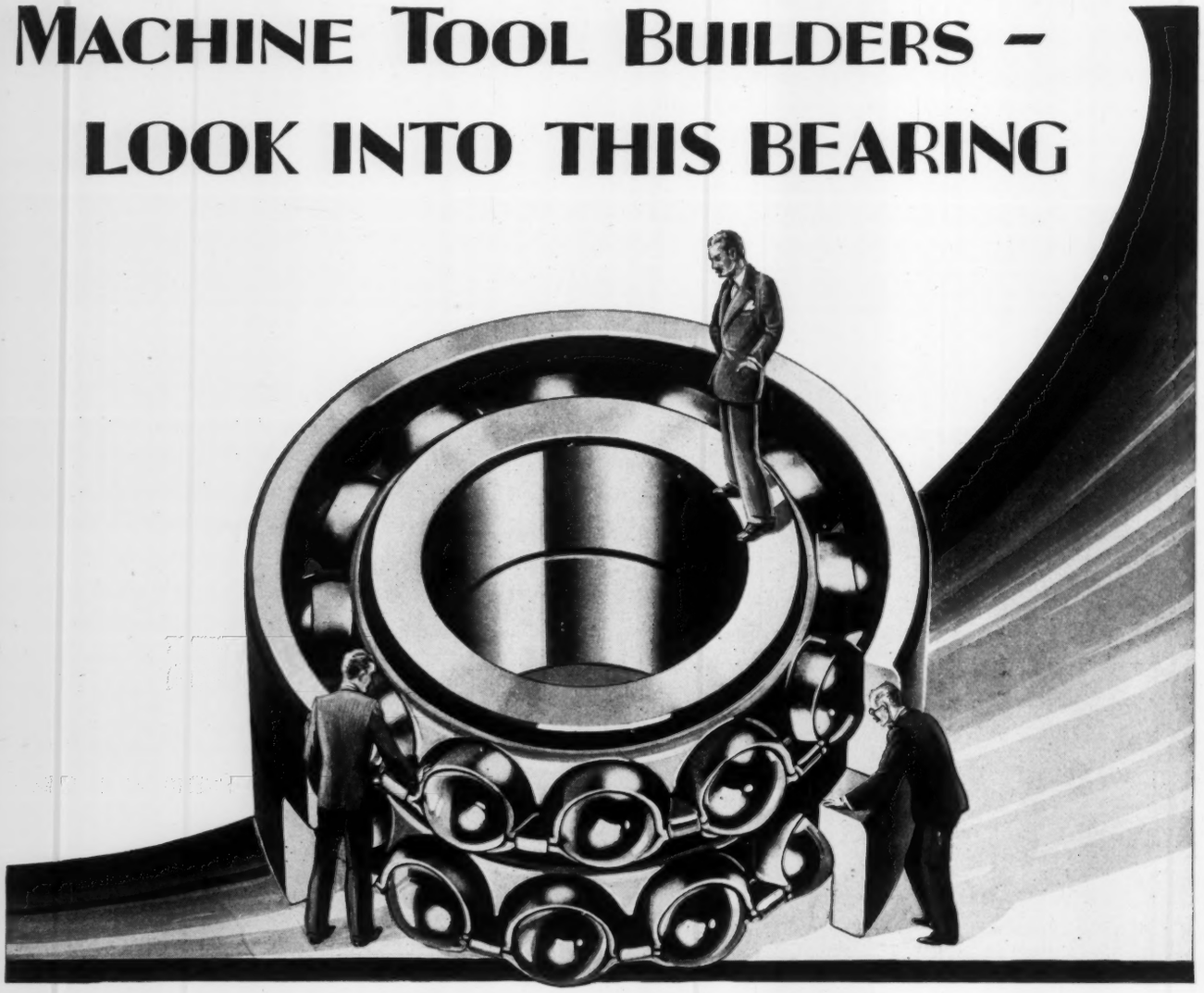
MACHINE TOOL BUILDERS – LOOK INTO THIS BEARING



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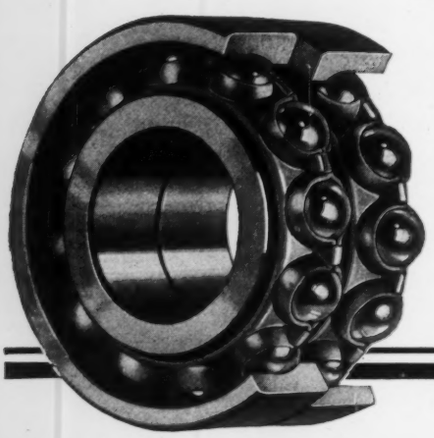

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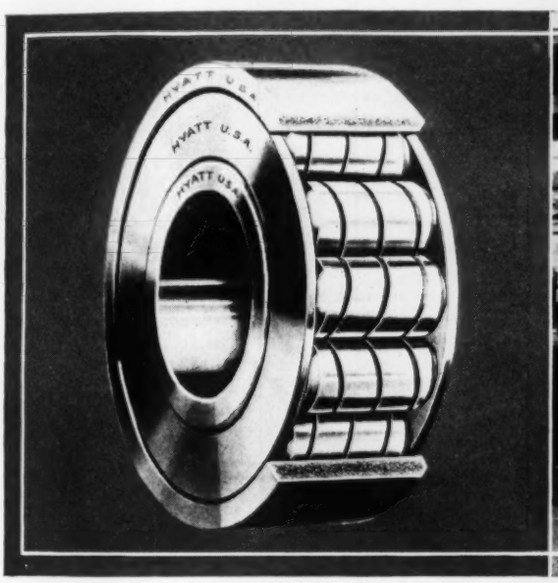

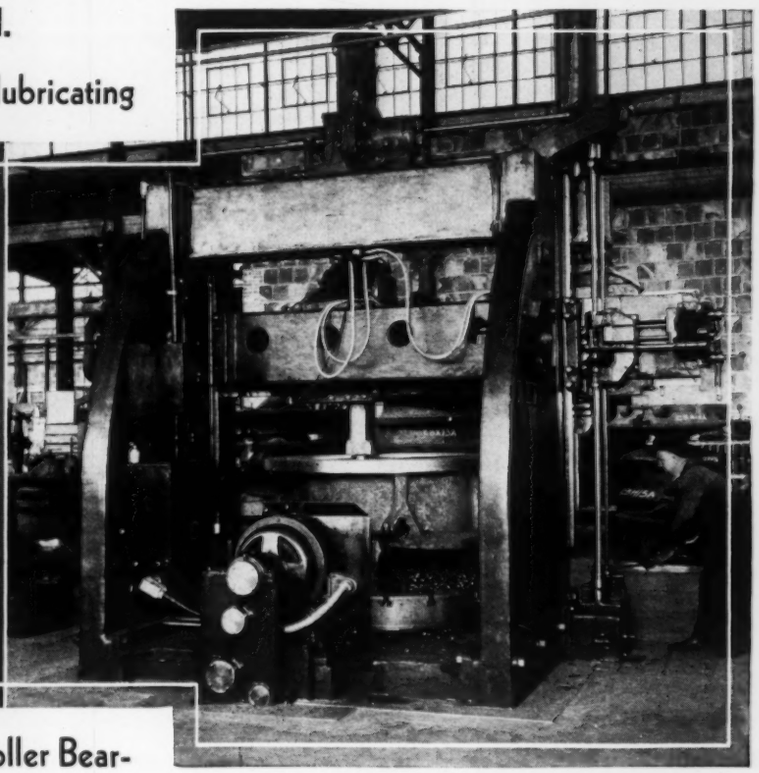

qualities also have helped Hyatt Roller Bearings to a forefront position in machine tool application.

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Calendar of Meetings and Expositions

May 19-22—American Society of Mechanical Engineers. Fourth national aeronautic meeting at Dayton, O., and Wright field. The meeting will be held under the auspices of the aeronautical division of the society. Orville Wright and Gen. B. D. Foulois will be the honorary chairmen. The program has been selected to afford interesting technical papers on a wide variety of live topics. Among the speakers will be Dr. Elmer A. Sperry, Lieut. J. Doolittle, Major G. E. Brower, Prof. Wagner, of Danzig, Germany, Claude Dornier, of Friedrichshafen, Germany, Per Orbem, of Paris, Lieut. A. F. Hagenberger and many others of equal prominence. The papers will cover both lighter than air and airplane types. They include problems of design and construction practice, aerodynamics, engine performance and fuel problems, quantity production, metal plane development, flying boats, autogiro, etc. A part of each day will be devoted to inspection tours of the extensive laboratories and hangars at Wright field and through nearby airplane and accessory factories. Some of the sessions will be held at Wright field. Headquarters for the meeting will be maintained at the Biltmore hotel, Dayton, O.

May 25-29—Society of Automotive Engineers. Summer meeting at French Lick Springs, Ind. A celebration of the twenty-fifth anniversary of the society will be held in conjunction to observe a quarter century of automotive progress. One of the features will be pretentious historical exhibit. The anniversary celebration will include, in addition to technical sessions on engines, transmissions, bodies, diesel engines, research, brakes and aircraft motor, an old-fashioned assemblage. A delegation of 30 French automotive engineers will attend, and it is expected that many prominent figures early identified with the industry will be present. Coker F. Clarkson, 29 West Thirty-ninth street, New York, is secretary of the society.

June 9-12—American Society of Mechanical Engineers. Semiannual meeting to be held at the Book-Cadillac hotel, Detroit. At least 20 technical sessions besides interesting plant inspection trips and entertainment are scheduled. Jervis B. Webb, of the Detroit section, is chairman of the arrangements committee. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

June 12-14—American Society of Mechanical Engineers. Third national meeting of the Oil and Gas Power division of the society to be held at Pennsylvania State college. Julius Kuttner, who is in charge of the technical program has announced that there will be about 15 papers presented at the five sessions. On Friday evening, June 13, a banquet will be held. An exposition will be held in the armory on the campus grounds at the time of the meeting.

June 16-20—Association of Iron and Steel Electrical Engineers. Annual meeting and iron and steel exposition at Broadway auditorium, Buffalo, N. Y. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director.

June 16-25—Second Plenary World Power Conference. To be held at Berlin, Germany. O. C. Merrill, Edmunds building, Washington, is chairman of the American committee.

June 18-25—American Railway association. Annual meeting of the mechanical division at the new auditorium, Atlantic City, N. J. During the same period an exposition of railway supplies and equipment will be held under the auspices of the Railway Supply Manufacturers' association. V. R. Hawthorne, 431 South Dearborn street, Chicago, is secretary of the American Railway association and J. D. Conway, 1841 Oliver building, Pittsburgh, is secretary of the Railway Supply Manufacturers' association.

June 23-27—American Institute of Electrical Engineers. Annual summer convention to be held at Royal York hotel, Toronto, Ont., Canada. F. L. Hutchinson, 33 W. Thirty-ninth street, is secretary.

June 23-27—American Society for Testing Materials. Annual meeting to be held at Haddon Hall, Atlantic City. The program as planned will include a symposium on aircraft materials and another on rosin together with a topical discussion on some phases of testing rubber products. A number of members have offered papers for presentation.

June 26-28—Steel Founders' Society of America. Semiannual convention at Greenbrier hotel, White Sulphur Springs, West Va. G. P. Rogers, 932 Graybar building, New York, is managing director.

Aug. 31-Sept. 7—International Congress for General Mechanics. Meeting in Liege, Belgium. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

Oct. 20-25—Dairy and Ice Cream Machinery and Supplies association. Annual exposition in Cleveland. Roberts Everett, 225 West Thirty-fourth street, New York, is secretary.

MACHINE DESIGN
May 1930

Space Is Limiting Factor in Design of Coal Cutting Machine

By L. E. Jermy
Managing Editor, Machine Design

FEW types of machines need to be designed from the aspect of limitations in space to the extent essential with coal mining equipment. There are many places in mines where it is possible only to crawl; yet in such restricted spaces machines are required to work and are working as satisfactorily as those designed without limitations in size. Enclosing electrical equipment or employing other methods of safety precaution also are primary considerations and other features entering into design are convenience of control and simple yet rugged construction.

A typical mining machine is shown in Fig. 4, which illustrates a coal cutter built by the Jeffrey Mfg. Co., Columbus, O. As originally produced the machine was considerably higher than shown in the illustration but developments in design now have reduced the overall height to 18 inches. The previous model was 25 inches high.

Differential Replaces Pulleys and Clutches

This reduction was made possible by repositioning a large bevel gear which serves as the driver for the cutter chain shaft, and further reduction was effected by means of a well designed system

Fig. 1—A coal cutting machine operating in thin seam. This indicates conditions these machines are designed to meet and the difficulties encountered in their operation in the mine

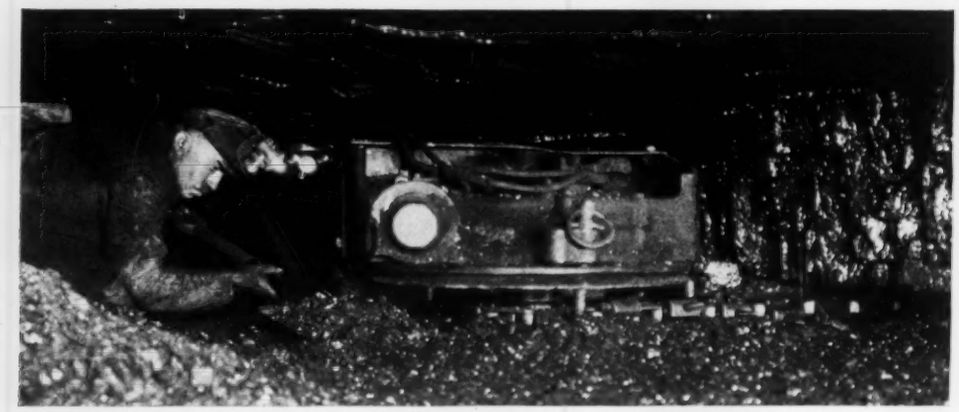


Fig. 2—As the coal is grooved during the passage of the machine across the seam, it is necessary for an operator to clear away the dust and small pieces

of two-speed planetary gearing for driving the rope drums, the gearing being used in place of a pair of pulleys and clutches on the earlier model. This feature will be discussed later.

It will be seen from the illustrations that the machine consists primarily of a comparatively heavy body from which projects a chain cutter bar. This bar ranges in length from 6 feet 6 inches to 10 feet 6 inches.

Cutting Chain Has Nickel Steel Rivets

Passing around the bar and driven by a sprocket on an auxiliary shaft is a chain having drop forged, heat treated links and lugs. Nickel steel rivets are employed for wear resistance. In the lugs of the chain at intervals of 6⅞-inch are rectangular slots into which are fitted the actual coal cutters. Each of these cutters is about ⅝-inch thick with a cutting edge resembling to an extent that of an ordinary lathe tool, but with considerably more rake. The cutting edge tapers to about ⅛-inch at the point.

It obviously was impossible to provide sufficiently wide cutting edges on the tools to provide clearance for the bar. To overcome this difficulty the tool carrier links of the chain were so designed that the rectangular slots in consecutive links are angularly disposed to each other. Nine different angles, from horizontal to 45 degrees above and below are employed, as may be seen in Fig. 4. This gives a total effective cutting width of about 5½-inch, or in other words sufficient to cut a curf in the coal seam wide enough to provide ample clearance for the bar.

A chain sprocket would be unsatisfactory at the tip of the bar due to tendency for the sprocket shaft bearing, the chain and the sprocket teeth to clog; therefore a semicircular plain bearing around which the chain runs is provided, of hardened steel. This has been found satisfactory in service.

Operation of the cutting machine is extremely interesting. Assuming that the machine has been lowered from its truck at the end of the tracks leading into a "room" in the mine, it is drawn sideways across the seam of coal to be undercut. The cutter chain first is headed into the corner of the room and driven into the coal seam. On another model of the machine on which the cutter bar rotates, the body of the machine is turned round gradually until its side first be-

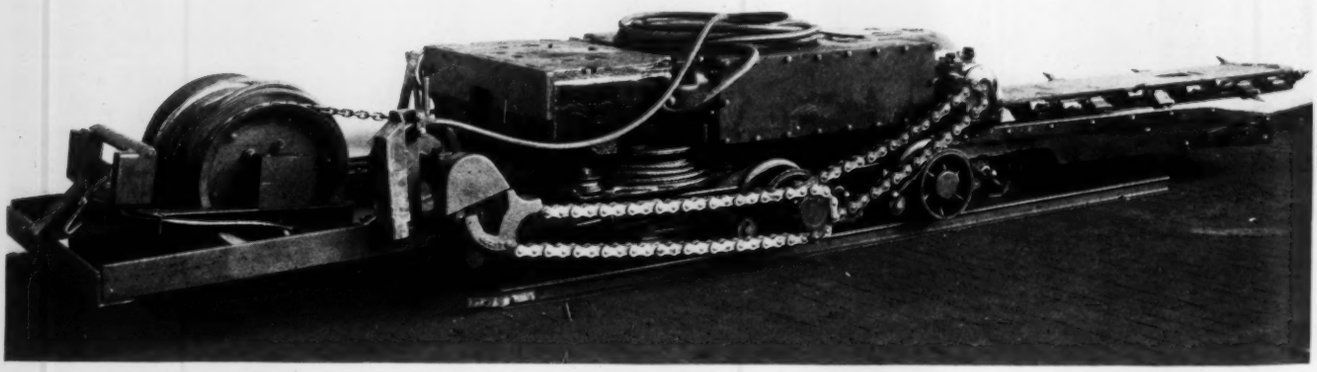


Fig. 3—Machine raised upon truck for handling. Note how drive is taken from machine shaft to truck axle. Drive at left is for cable drum

comes parallel with the face of the coal; it is then turned still further and is locked with the cutter bar when at an angle of 10 to 20 degrees to the face. The machine then is drawn along the face and the 10 to 20 degree angle of the bar eliminates any tendency for the machine to push away from the seam.

Eliminate Danger from Explosions

When the machine has been drawn across the full width of the room, usually about 30 feet, it is withdrawn and the seam above the curf is drilled for "shooting." Special cartridges are employed to obviate danger from explosions. The shots take effect on the coal in a downward direction and rather than blasting it, crumble it away in a condition more or less suitable for loading on cars.

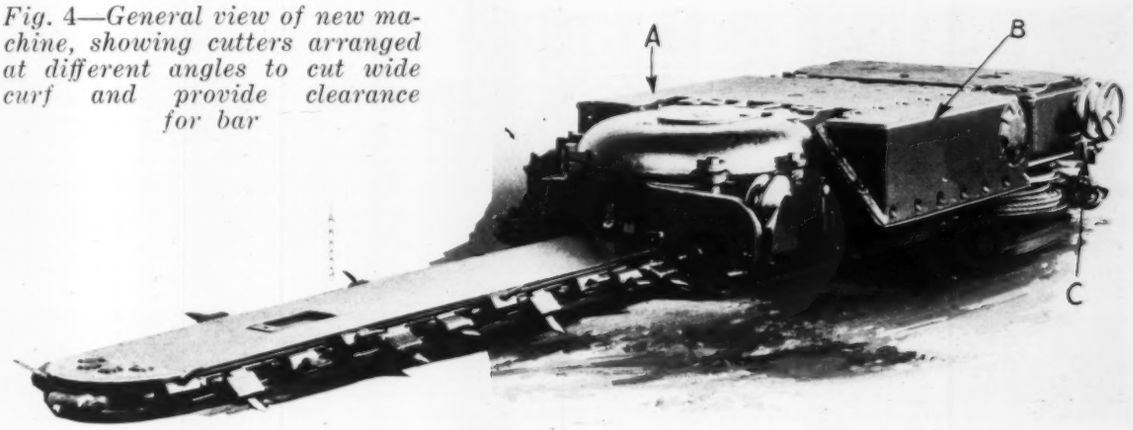
The machine in Fig. 4 has a 50 horsepower reversible motor. As will be understood it is necessary that this motor and all electrical control be thoroughly enclosed for mine operation. In the center of the body of the machine, as shown at *A*, Fig. 4, the motor is mounted, and all controlling mechanism including the contactor, relay and reverse switch are enclosed in the control case shown in Fig. 6 and at *B*, Fig. 4. Study of these features will indicate the exacting care with which it was necessary to design the power unit of the machine in order to conserve height as much as possible.

All the movements of the new machine when it is off its truck are effected by means of wire ropes operating around two drums on the machine, one of which may be seen in Fig. 4. Suitable lugs and pulleys are provided at different points to facilitate movements backward, forward or sideways. It is for driving these drums that the 2-speed planetary gearing is employed. Low speed is used for the cutting operation and high for handling the machine. The drive for each of the drums is taken from a worm on the mainshaft and through a worm wheel on which is mounted a spur gear for driving the planetary gears. The two speeds are effected by providing internal gear rings having different numbers of teeth and locking one or the other ring by means of brake bands to obtain differential action. Speeds of about 19 inches per minute and 22.5 feet per minute are obtainable.

Internal gearing also is employed for the final drive for the drums. These drums are mounted on eccentrics for the purpose of disengaging the internal gear from the drive gear when desired in handling the machine. The shift lever for operating the eccentric for the left hand drum is shown at *C*, Fig. 4, and a similar lever controls the drum located in a similar position at the other side of machine.

Significant in the design of the cutter is the location of the major controls. These all have been arranged to be within easy reach of the operator, a feature desirable on all machinery to aid elimination of lost motion and ease in handling. This is particularly the case where conditions are cramped to the extent in mining. An operator lying or bending on hands and knees besides the machine is able to manipulate the controller reverse lever; the fast handling or slower cutting speed handwheels; the controller operating handle; and the eccentric for freeing the adjacent drum from the driving mechanism.

Fig. 4—General view of new machine, showing cutters arranged at different angles to cut wide curf and provide clearance for bar



Truck Has Tilting Platform

To facilitate moving the machine around the mine, a special truck is provided. This has a tilting platform and a turntable, the latter being employed when it is necessary to point the machine in a certain direction and still permit the truck wheels to remain on their track. For especially low coal the turntable is mounted between the wheels of the truck instead of above them,

and the swing of the turntable thus is prevented.

When it is desired to drive the truck on the rails a chain connection is made with the power unit

SPECIAL significance is attached to the accompanying article at this time in view of the Mining Congress held May 5-9 at Cincinnati. At the technical sessions many papers were presented dealing with the rapidly increasing mechanization of mines and other phases of the mining industry. Many machines similar to the one described on these pages were exhibited at the exposition held in conjunction with the congress. Other machines shown included the coal loader referred to on page 20 of the April issue of MACHINE DESIGN, *conveyors, drills, etc. The exposition was said to be one of the most comprehensive of its kind ever held, proving that mine operators now realize fully the advantages to be gained from well designed and correctly applied machinery.*

of the cutting machine. As shown in Fig. 3, a driving sprocket is provided at the end of an auxiliary shaft on the cutter and the chain is passed around this when the cutter is loaded on the truck; the cutter first is pulled on far enough to enable the chain to pass over driver and driven sprockets and then is moved back and locked to give the chain the correct driving tension. Both axles of the truck are connected also by driving chain for additional traction.

Another interesting drive on the truck is that to the mechanism for operating the electric cable

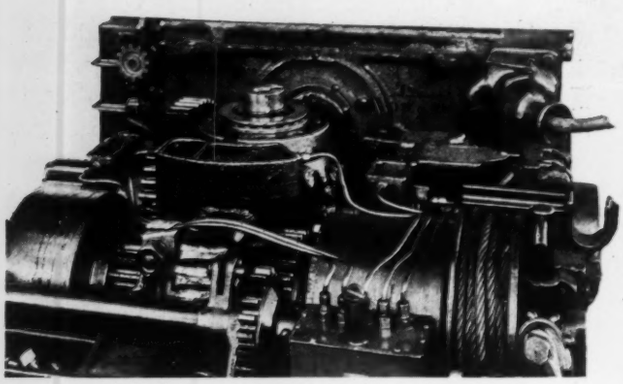


Fig. 5—Gearing mechanism of early machine which has been redesigned to reduce the total overall height of the unit

drum. The cable is passed out as the machine is taken into the further recesses or rooms in the mine, and to facilitate this and also the winding in of the cable the drive shown in Fig. 3 is used. This consists primarily of a chain from the nearer truck axle to a clutch shaft. On this shaft a plain sheave is mounted around which is passed a length of cable chain connecting it to a pulley on the drum. The purpose of the plain pulleys is to provide for a certain amount of essential slip as the periphery of the winding circle varies, thus

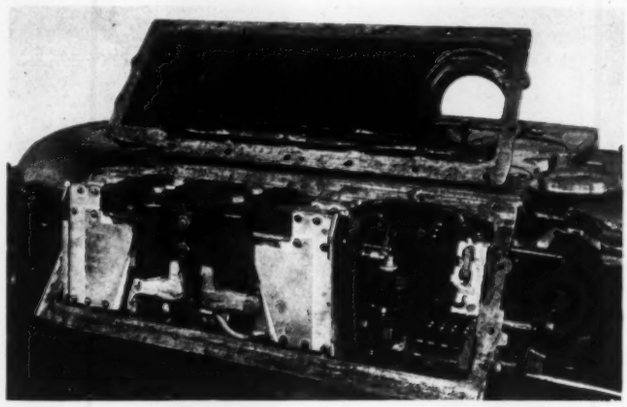


Fig. 6—Control case with cover lifted to show contactor, relay, reverse switch, etc.

keeping the cable under slight tension. The use of chain for such an application is not common. Belting had, however, been tried and was found unsuitable due to the severe conditions inherent in mine operation. Other devices in the form of friction clutches etc. might be used, but in equipment of this kind the additional space taken by both the device and guards, and the extra expense involved, often does not warrant these changes. This is particularly the case where the operation of the equipment to be driven is intermittent.

Textile Lubrication Important

LUBRICATION of textile machinery is a subject about which much interesting discussion is being written. The problems in this field offer an interesting study and particularly in cotton mills and rayon plants the necessity of forestalling overheating of bearings makes the question of lubrication of utmost importance.

A heavy lubricant generally is used to provide positive lubrication for gears since a sufficient film on the teeth not only prevents friction and wear but also reduces the possibility of sparks if the gears mesh unevenly. Lubrication of the comb box of a carding machine always has caused some concern. Many have considered grease or a fairly viscous oil as the proper lubricant. However, medium straight mineral oil has been used advantageously. The inherent preference for heavy lubricant has been due to the necessity of eliminating splashing or throwing from the box.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Features and Trends in Design

MANY pertinent design features were incorporated in the "Silver Bullet," the 4000 horsepower car which attempted to break the speed record at Daytona Beach this year. The attempt failed due to difficulties in the engine induction system and an unprecedented rough beach, but the car is of particular interest because of the thoroughness with which Louis Coatalen, its designer, attacked the problem of building it.

As an instance of the modern tendency toward blending the activities of the operator with the functioning of the machine, it might be said that never before were driver and car so perfectly coordinated. The two twelve-cylinder engines, of the V type, were designed specially instead of adapting engines already built. Whereas a 60 degree angle of the V type ordinarily would have been used, a 50 degree angle was decided upon in order that the engine be no wider than the driver's shoulders. It is interesting to note that to determine this the driver's silhouette was marked on the wall from a projection of his shadow. In this way the body of the machine was kept to the smallest possible size. The remarkable stream-lining worked out showed in wind-tunnel tests that the "Silver Bullet" had only 42 per cent of the resistance of Seagrave's "Golden Arrow," the present record holder.

Cylinders Lined with Nitrided Steel

The forward engine carries the water and oil pumps for the two 2000 horsepower engines which are mounted tandem fashion, while the supercharger is driven by the rear one. A section of the engine is shown in Fig. 1, the bore and stroke being 5½-inch and 5⅛-inch respectively. The cylinder blocks are of aluminum alloy, with an inserted nitrided steel liner in each cylinder. The nitrided steel is hard enough to scratch glass and still shows the original fine grinding marks after considerable usage. The connecting rod big end and its cap, both of which are hardened, bear on a case-hardened crank pin, 2⅜-inch diameter by means of two adjacent roller bearings having rollers ¼-inch diameter and ¼-inch long, while the connecting rod of the opposite cylinder has a big end straddling the other rod and a roller bearing of the same size in each member of the fork. The main bearings also are of the double roller type, with split outer races. Inserted valve seats are used, as well as concentric valve springs and a slipper to take the cam thrust from the valve stem. A train of gears at the forward end drives the overhead camshafts. There are four valves per cylinder and a single, centrally-located spark plug.

Positive Clutch Supplements Disk Type

AT THE rear of the crankshafts of the two engines are spur gears driving a lay shaft below the crankshaft and within the crankcase

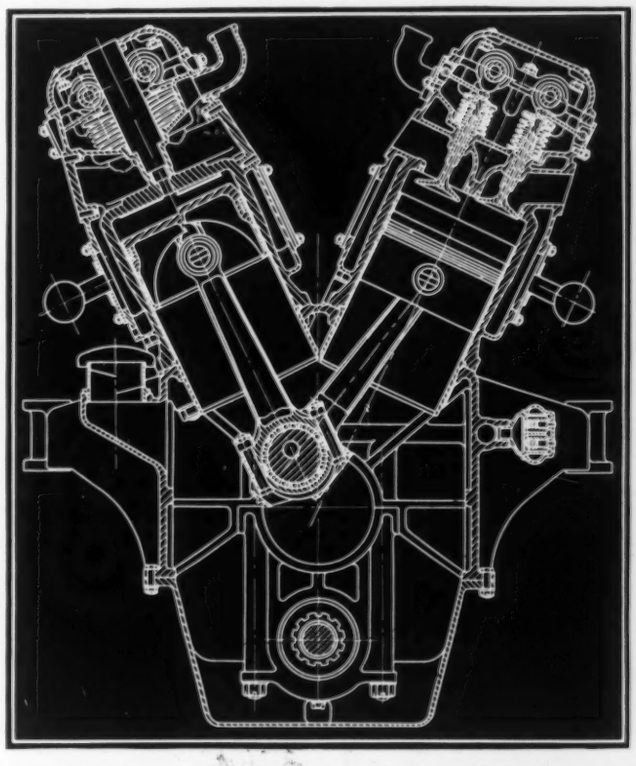


Fig. 1—Section of one of the 2000 horsepower engines used in the "Silver Bullet." Note the nitrided steel liners which are inserted in the cylinder bores for wear resistance

at a ratio of 30-13. A coupling connects the two lay shafts which has a slight universal effect, to allow for weaving of the frame and resultant shaft misalignment. A similar coupling at the rear of the second engine connects with the clutch and transmission unit. Lay shafts, clutch and transmission are speeded up to reduce the torque which they must transmit, allowing lighter construction. The multiple disk clutch which is only capable of transmitting part of the engine torque is supplemented by a positive clutch member whose teeth mesh with the clutch drum serrations in the fashion of an external-internal gear clutch.

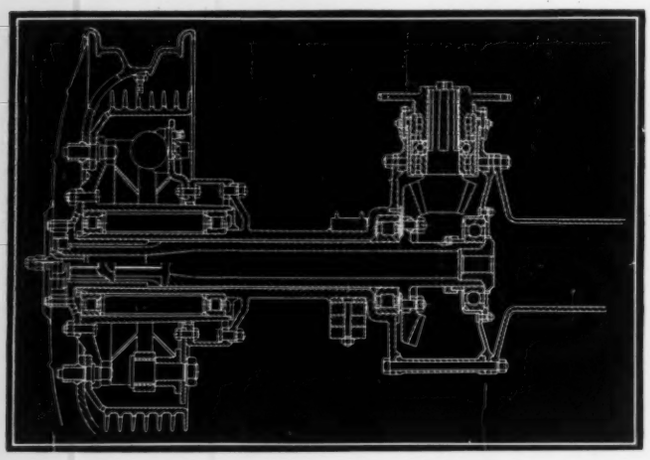


Fig. 2—Portion of rear axles showing built-up construction. The roller bearings shown, and others in the car, were designed specially to withstand the tremendous centrifugal forces involved

The transmission has three speeds forward and one reverse. There is no direct drive. On the main shaft are carried sliding gears which mesh with gears on a countershaft above it and to the left. The countershaft in turn drives a shaft to which the left propeller shaft is attached. A right shaft and its propeller shaft also are driven by the countershaft through the intermediary of an idler necessitated by the center distances involved. Because of the high speed of rotation no oil level is carried in the transmission case. Two oil pumps are used and function in the same way as the two pumps which supply oil to the engines with their "dry sump" system of lubrication.

Wheel Torque Reactions Are Balanced

EACH wheel has its individual bevel gears which necessitates the two propeller shafts mentioned above. These rotate in opposite directions, thereby balancing the torque reactions of the wheels. The driver sits between the two propeller shafts, permitting his low placement. The sectional view, Fig. 2, of a portion of the rear axle shows the built-up construction employed. Gear and wheel thrusts are taken by the large ball bearing. All the roller bearings in the car, including the engine, were built specially because with the high speeds involved the centrifugal forces developed prohibited the use of standard bearings. The hydraulic brake cylinder is shown in the section, one being in each wheel. Silk cords are employed in the tires and the tread is only ½ millimeter thick because of the centrifugal forces involved. Overall ratio between engine and wheels is 1.04—1.

At the base of the steering column a bevel gear meshes with a gear at each side, secured to independent transverse shafts having a Marles type steering head at each frame rail. The steering arms swing in a substantially horizontal plane, each one controlling a front wheel steering arm through a jointed connecting link. This individual control prevents synchronous vibrations of the wheels and shimmying.

Two vertical fins at the rear of the body

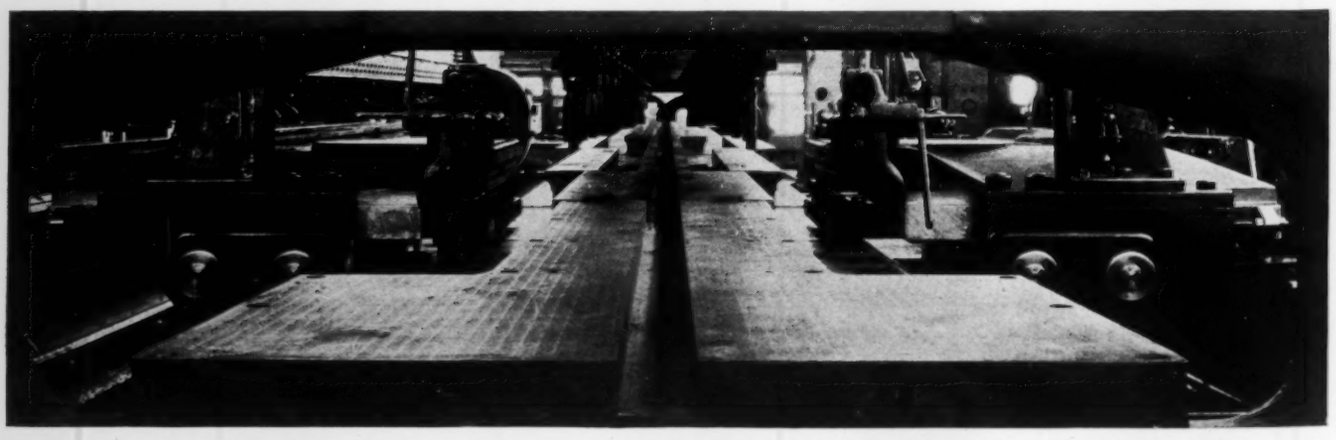


Fig. 3—Bed of trimming machine designed for continuous method of operation. Plates are drawn in, trimmed and ejected at the far end of machine for other operations

stabilize the car's movement at high speed. A normally horizontal fin therebetween is used as an air reaction brake when the driver pulls a cable releasing a locking pin. The fin then swings into a vertical position and offers a resistance of half a long ton at 250 miles an hour. The wheel brakes of the motor car are greatly relieved of strain by the action of this fin.

Trimmer Embodies Unique Features

AN EXCELLENT example of the continuous operation method of manufacture is incorporated in a new plate trimming machine built by William Sellers & Co. Inc., Philadelphia. This machine, the bed of which is shown in Fig. 3, is designed to trim steel plates up to 50 feet long, ¼ to ½-inch thick and 31 to 55 inches wide, as used in the manufacture of welded steel pipe.

In making the pipe by the straight line production method the trimmer plays an important part inasmuch as it receives the plate directly from the rolling mill and prepares it for other operations. A roller table delivers a plate to one end of the machine; the plate is then drawn in, trimmed and ejected at the opposite end for welding, rolling, facing, etc.

A 250 horsepower reversing motor is used to drive the machine which consists essentially of a long cast iron bed with a steel girder above for the clamping mechanism. A saddle and tool slide are provided at each side equipped with an operator's platform and push button control. The top surface of the bed is covered with renewable, hardened and ground steel plates on which are held adjustable blocks. These can be moved to and from the center of the bed to support plates of various widths close to the point of cut.

Air Clamps Hold Plate Securely

The plates are clamped in position during trimming by the 50 air jacks, which are carried by the 65 feet long girder above the table. Air cylinders at the top of the girder actuate the jacks which are arranged in two rows. Each has a pressure of 5,000 pounds giving a total of 250,000 pounds on the plate. This pressure can be relieved and the plate raised from the table in seven seconds.

A rod running the length of the machine, with conveniently placed handles, controls the air valves supplying the cylinders. To resist further the cutting pressure, the plate is set so as to abut against two spring kick up stops located near the loading end of the machine. These are depressed by the weight of the plate when being drawn in.

Each tool slide is arranged for 32 tools, 16 being held in a manifold tool holder above the plate and 16 below. The leading tools take broad and shallow cuts while succeeding tools take narrower and deeper cuts until the plate is trimmed through completely by the last two overlapping tools.

Worthy of note as another instance of centralized lubrication, is the fact that a rotary pump connected to the armature shaft of the motor supplies oil to the gear train, screws, saddles, etc.

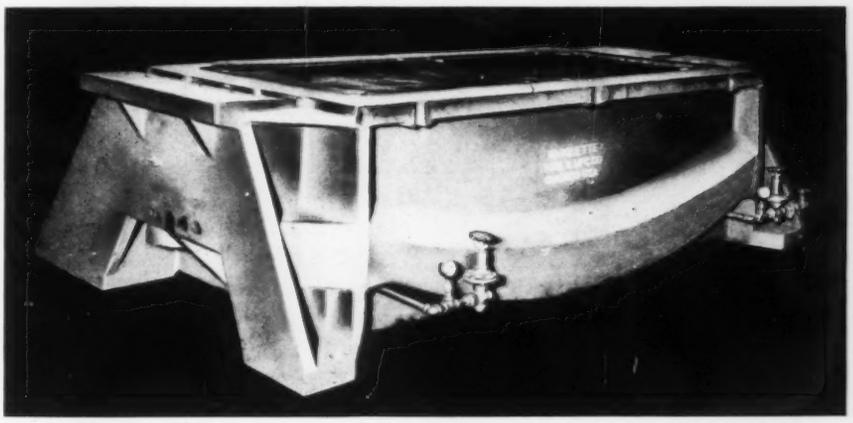


Fig. 4—Cushioned press bed which can be built into a press to form an integral part of the machine

The pump draws oil from a large reservoir and a purolator in the supply line as well as strainers in the return lines assure clean oil.

Facilitates Re-arrangement of Shops

WITH the growing demand for portability and facilities for moving heavy equipment from one place to another in production plants, interest attaches to the cushioned press bed shown in Fig. 4. This is a product of the Marquette Tool & Mfg. Co., Chicago, and is intended to be built into the press as an integral part. The most important feature claimed by the manufacturers is the elimination of deep pit foundations which formerly were necessary to accommodate the blank holding cushion under the press bed.

The new bed also is more self-contained than earlier models and makes unnecessary the installation of pressure tanks. The bed itself acts as a reservoir for the displacement of the compressed air or fluid which flows from the cushion

into the space surrounding it. Formerly installed near a separate tank, the pressure gage and regulator now can be placed directly on the bed of the press convenient to the operator.

Combines Rotation and Reciprocation

PLACED on the market recently by the Globe Products Co., Cleveland, the "Rotapiston" pump is claimed to have the suction lift of the piston type of pump and the simplicity of the rotary type.

The design of the pump is such that only four

Fig. 5—Cycle of operations of Rotapiston pump showing suction, mid-stroke position and discharge

moving parts are required—a camshaft, two pistons and a revolving rotor. The camshaft is placed slightly "off-center" with the rotor, and the revolution of the cam causes the two pistons, set at right angles to each other, to move back and forth in the rotor. Since the camshaft is off-center, however, and since the center line of the camshaft necessarily must coincide with the center line of the piston, the rotor revolves so as to present each face of the pistons to the discharge and suction ports in succession, as shown in Fig. 5. One result of this design is that the camshaft revolves at twice the speed of the rotor, thus enabling a high-speed motor to be used while still keeping the speed of the pump at a slower and more desirable speed.

Develops Leakproof Split Bearing

DIFFICULTIES encountered in the design of an essentially leakproof split bearing of the oil ring lubricated type have been overcome successfully by the Westinghouse Electric & Mfg. Co. in their split sealed sleeve bearing employed for large motors.

Observation had disclosed to the engineers engaged in the development of the bearing the fact that the oil gaining access to the crevice between the halves of the housing on earlier designs of oil-ring bearings was drainage from the interior walls of the upper part of the bearing housing, and that the oil deposit on these walls was a multitude of particles, invisible for the most part, thrown off from the oil rings. Shaft shoulders adjacent to the bearing surface usually were well shrouded, thus avoiding escape of oil particles from this source, but oil rings never were fully guarded.

In the new bearing, the oil rings and other sources of oil spray are enclosed fully at all points above the level of the oil in the reservoir, the enclosures forming part of the bearing itself. The air space within the housing around the bearing thus is entirely separated from the chambers in which the oil rings turn, so that during operation of the bearing, as well as during periods of rest, the air in this space is free from oil spray. The interior walls of the housing remain dry, and leakage through and along the crevice between upper and lower halves of the bearing housing thus is prevented.

Fig. 6 is a perspective view of the bearing housing cut through the vertical centerline and half removed to expose the bearing. The oil rings are shown at "A." A portion of one of the oil ring guards "B" is shown cut away, exposing the ring and disclosing the shape of the chamber enclosing it. During operation, oil is filled into the reservoir until the lower edges "C" of the oil ring guards are submerged about ¾-inch.

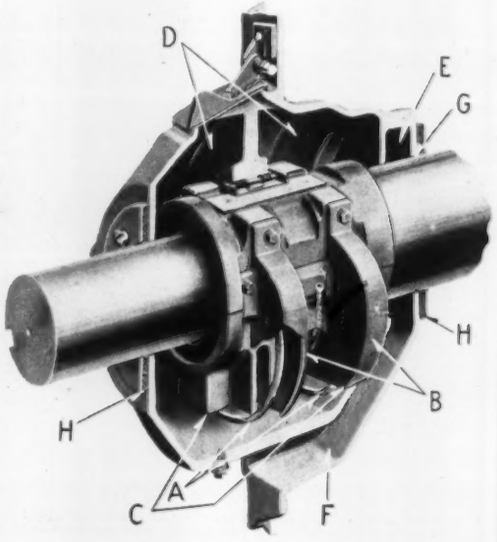


Fig. 6—Leak-proof bearing for large motors. Oil rings are enclosed in chambers

At the inner end of the housing a separate annular chamber "E" is interposed between the bearing housing proper and the point where windage suction occurs. This chamber is vented to the external atmosphere by a duct "F" which supplies air leakage occurring through the annular clearance space "G" around the shaft, and avoids exposing the air chambers "D" of the housing to high windage suction. The felt washers "H" shown at the ends of the housing are not required to prevent oil leakage, being added only as a dust-proofing means.

Corrosion Resistant Steels Solve Many Problems of Designers

By H. A. De Fries

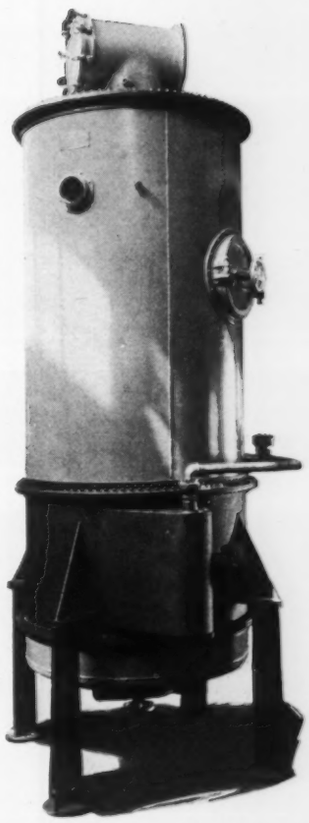


Fig. 2 — Chrome-nickel steel is used in the fabrication of this milk condensing vacuum pan, indicative of the employment of the alloy in equipment for the food industry

WITHIN the last few years demand for corrosion resistant chromium and chromium-nickel alloys for machine parts has increased enormously.

They have been almost universally adopted in the design of machinery for the chemical and allied industry or wherever corroding materials are handled, and washing machines, refrigerator parts and other household appliances are made from these alloys.

The food industry found that these alloys not only resist successfully the attack of organic acids but also that they do not impart a metallic taste to food stuffs when in contact with them.

With this ever increasing demand upon the machine designer for reliable equipment he is confronted with the important problem of selecting the proper and most reliable grade of corrosion resistant alloy and also with specification of the proper treatment, working, etc. in order to retain to the fullest possible extent the properties and characteristics of the metals.

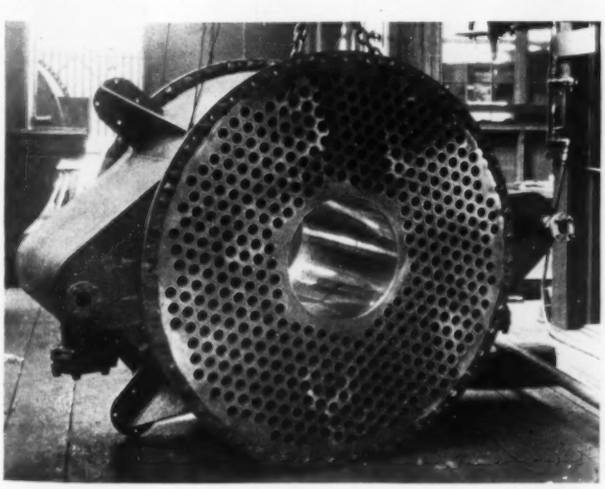


Fig. 1—Steam chest used in the construction of the vacuum pan shown above

Chromium and chromium-nickel iron and steels are by no means new. Their invention dates back nearly twenty years. In the early days their structure and properties were little understood and they presented many obstacles to successful working. Much credit is due to Dr. Straus of the Krupp research laboratory for a painstaking study of their characteristics and for developing means and methods for overcoming these difficulties.

Outlines Conditions of Application

Factors governing successful working and application of the metals may be condensed in the following:

An addition of about 13 per cent chromium makes iron passive, which means it acquires great resistance to the influence of water and oxygen from the air. However, carbon is always present as an adjunct to iron and this element can destroy passivity as soon as it appears as free carbide in chrome alloy steel. Even a small percentage has a great influence upon the structure. When the carbon is retained in solution, as can be achieved by heat treatment, the passive condition remains. By adding nickel to chromium steels it also is feasible to retain the carbon in solution, as then is formed austenite, in which carbon, chromium and nickel occur in complete

solution. From foregoing considerations it easily is seen that noncorrosive chromium and chromium-nickel alloys should always be used in the heat treated condition, in order to obtain anticorrosive properties as well as machineability, ductility and workability.

These heat treatments vary for the different grades of material and will be cited in their respective places in the article. From the standpoint of the machine designer, for whom this contribution has been specially written, two alloys will cover most requirements, but they should be most carefully selected and the required strength studied separately from corrosion resistance. In selecting one or the other of these corrosion resistant alloys, it should be considered whether the machinery for which it is to be used requires machined parts, welded parts or deep drawn parts. No material should be selected by the engineer or designer which is lacking in one of these properties or the other.

RAPIDLY increasing employment of noncorrosive nickel chromium alloy steels renders authoritative information on their analyses, properties and application extremely valuable to the designer. MACHINE DESIGN *therefore prevailed upon H. A. De Fries, chief metallurgical engineer of the Associated Alloy Steel Co., Cleveland, to prepare the accompanying special article as an introduction to the material which will appear from time to time on these alloys. Corrosion data and information on machineability and workability will be published in an early issue.*

The two grades of steels mentioned comprise the KM (Martensitic) group and the KA (Austenitic) group. Their principal members, with respective application, will be described separately.

Heat Treatment: KM-1 is an oil hardening steel. For maximum hardness (spring temper of about 430 Brinell) quench in oil from approximately 1690 degrees Fahr.

Normal heat treatment for best machining and anticorrosive properties: Quench in oil from 1650—1690 degrees Fahr. and draw at 1150—1250 degrees Fahr.

Application: On account of its strength KM-1 finds principal application as highly stressed machine parts such as turbine blades, shafting, piston rods, chain parts, machine knives, plungers, spindles, valve trim and complete valves.

Table I

Analysis and Properties of KM-1 Alloy

Average analysis:	
Element	Per cent
Carbon (maximum)	0.18
Manganese	0.30 to 0.60
Silicon	0.50 to 0.75
Chromium	13.00 to 14.00
Nickel	1.50 to 2.00
Physical properties (normally heat treated):	
Specific weight	7.73
Specific heat	0.11
Heat conductivity	0.07 cal. cm / sec. 1° C
Coefficient of linear expansion:	
0 degrees to 100 degrees Cent.	0.000010
0 degrees to 400 degrees Cent.	0.0000118
0 degrees to 500 degrees Cent.	0.000012
Electric resistance	72 microms cm
Tensile strength, pounds per square inch	110,000 to 140,000
Elastic limit, pounds per square inch	90,000 to 100,000
Elongation (10d), per cent	11 to 14
Reduction in area, per cent	60 to 65
Brinell hardness	230 to 300

It cannot be deep drawn and can be welded only with difficulty. For high temperature service it can be used in the heat treated condition up to 1100 degrees Fahr.

Corrosion Resistance: KM-1 is magnetic, martensitic steel and therefor obtains its maximum corrosion resistance only in the heat treated condition. The anticorrosive properties also are dependent upon the finish and all articles made of KM-1 should have a ground or polished surface.

Welding and Brazing: Welding of this alloy should be avoided wherever possible. During welding, changes in the chemical composition may occur, which would destroy anticorrosive properties. Air hardening cracks also may develop. Physical properties will change, making it imperative to reheat treat after welding.

In brazing, however, especially in silver soldering carried on below 1300

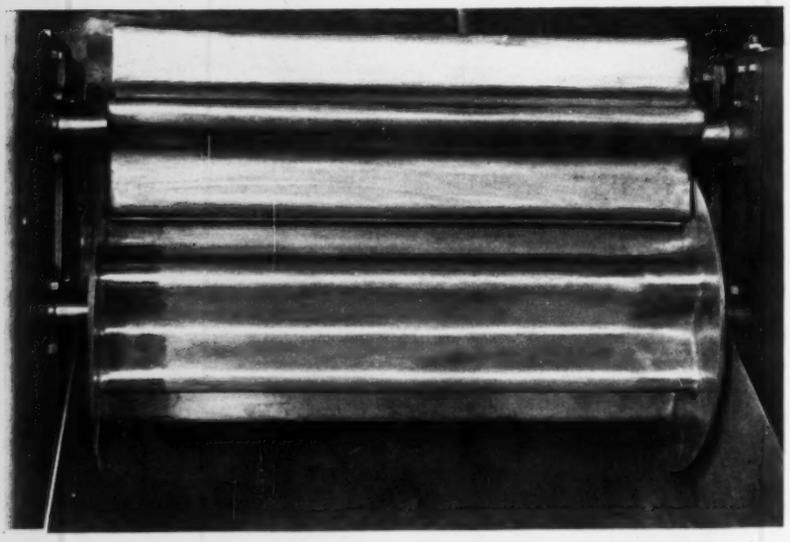


Fig. 3—Chrome-nickel corrugated rolls of an orange crushing machine

degrees Fahr., the physical properties will be retained and there is little danger from air hardening cracks. At a higher brazing temperature some light air hardening will occur, but this can be overcome by another draw at 1200 degrees Fahr.

Heat Treatment: To impart to KA 2 steel maximum corrosive resistance, ductility, workability and best machining properties, heat quickly to 2050-2150 degrees Fahr. and cool rapidly in air and water, depending upon the section being treated. This treatment is necessary after all hot work performed at a temperature in excess of 900 degrees Fahr., or after severe cold working, in order to restore full corrosive resistance and ductility. It also should be applied after welding.

Application: KA 2 can be fabricated into almost any article, as it can be machined, formed, deep drawn, spun and welded. It furthermore possesses great resistance to abrasion. Its principal application in machine design has been in evaporators, digesters, distillation apparatus, shafting, agitators, condensors, pumps, evaporators, screens, nozzles, plungers, pistons, cookers, paper and pulp machinery, washing machines, and other apparatus used in the chemical and allied industries. It also has been successfully employed against corrosion at the high temperature and pressure encountered, for instance, in oil cracking.

Table II

Analysis and Properties of KA2 Alloy

Average analysis:	
Element	Per cent
Carbon (maximum)	0.16
Manganese (maximum)	0.50
Silicon	0.30 to 0.75
Chromium	17.00 to 20.00
Nickel	7.00 to 10.00
Physical properties (normally heat treated):	
Specific weight	7.86
Specific heat	0.118
Heat conductivity	$\frac{0.052 \text{ cal. cm}^3}{\text{sec } 1^\circ \text{ C}}$
Coefficient of linear expansion:	
0 degrees to 100 degrees Cent.	0.000016
0 degrees to 600 degrees Cent.	0.000018
0 degrees to 1000 degrees Cent.	0.000020
Electric resistance:	
At 20 degrees Cent.	73 microms cm^3
At 100 degrees Cent.	90 microms cm^3
At 500 degrees Cent.	106 microms cm^3
At 800 degrees Cent.	118 microms cm^3
Tensile strength, pounds per square inch	85,000 to 95,000
Yield point	30,000 to 40,000
Elongation, per cent in 2 inches	55 to 60
Reduction in area, per cent	70 to 75
Brinell hardness	135 to 145
Charpy impact value, foot pounds	100 to 110

Corrosion Resistance: Whereas the alloys of the KM group must be finished with a perfectly smooth polished surface in order to retain their rust resistance, the steels of the KA group need only be ground or pickled until a bright surface is obtained. However, this special heat treatment is indispensable in bringing out the best properties. With proper heat treatment KA 2 is fully

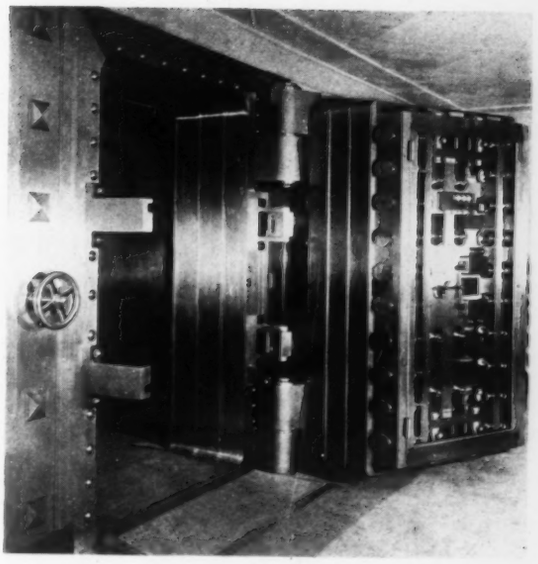


Fig. 4—Bank vault and operating mechanism made from anticorrosive steel

immune against atmospheric and most acid corrosion with the exception of sulphuric and hydrochloric acids. Wherever the acid corrosion is extremely severe, as for instance with a mixed acid composed of sulphuric plus nitric acid, then a modification of the KA 2 analysis is used. This change is only in the carbon content which is lowered to a maximum of .07 per cent.

Welding: KA 2 is welded readily by either the electric arc or oxy-acetylene flame. It also can be resistance welded in the lighter gages but cannot be hammer welded. As stated under the paragraph for heat treatment all welded parts should be reheat treated after welding, in order to restore full corrosive resistance at the weld. This practice may not be feasable in many instances. In such cases the modified KA 2 analysis with maximum .07 per cent carbon should be used, which does not require heat treatment after welding. It is essential, however, that all parts, even with this analysis, receive proper heat treatment before being welded together.

Effect of Manganese on Steel

The bureau of mines recently published a new technical paper, No. 466, by B. M. Larsen, which deals with a recent study of the characteristics of low-carbon manganese steel and of the effect of manganese on abnormality in case-carburizing steels. Certain phases of the problem could not be finished entirely, but some rather marked effects of manganese on the distribution of carbides have been observed, and the results obtained are enlightening in relation to the modifying effects of manganese on low-carbon steels.

General Considerations in Designing Mechanical Springs

By A. M. Wahl

Part I—Rational Method for Helical Spring Design

IN THIS article, first of a series by A. M. Wahl, research laboratory, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., reasons why much of our present spring design is empirical are pointed out. Of extreme value to designers is the rational method, based on the tensile and fatigue properties of the material, which is suggested for choosing the working stresses in springs.

IN FEW instances in designing machinery will it be possible to avoid the use of a mechanical spring in some form or other. In fact, most of our machines depend for their operation on not one, but several mechanical springs. For these reasons the designer who wishes a good design should become familiar with the fundamentals underlying the design of mechanical springs. This article is an attempt to supply the designer with some of these fundamentals and to correlate with them some of the scattered information which has appeared from time to time.

In spite of the fact that much research has been expended on mechanical springs and spring materials in recent years, it is true in general that the design of mechanical springs still is largely empirical. This is so for several reasons. One is that the formulas generally used for calculating the stress in certain types of springs may, in many practical cases, be greatly in error. For example, it is but recently that an investigation yielded conclusive evidence that the commonly used formulas for calculating stresses in helical springs having a small index, i.e., ratio of mean coil diameter to wire diameter, may err considerably. This investigation showed both analytically and by test that where the spring index is three, the true stress was about 60 per cent greater than that computed by the ordinary helical spring formula. In case of an index of four, a 40 per cent error is made by the use of the ordinary helical spring stress formula. The same thing applies in a lesser degree to torsion springs; for instance, in the case of a torsion spring of circular wire having an index of three, it may be shown by the use of the curved bar theory, as pointed out in an article by J. K. Wood on "New Torsional Spring Formulas" in *Iron Age*, June 23, 1929, that the maximum bending stress is around 30 per cent greater than that figured by the ordinary formulas for torsion springs.

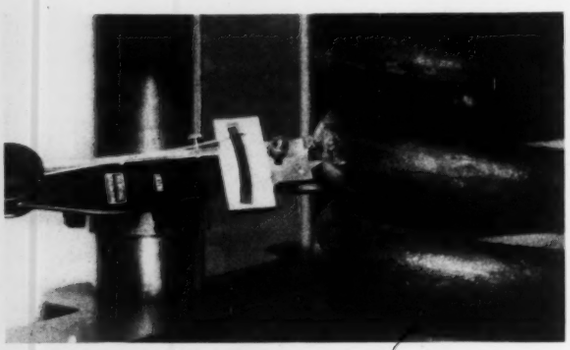


Fig. 1—Method of measuring stresses in helical springs

Furthermore, many of the present formulas for square wire helical springs axially loaded are in error for two reasons, first that they do not consider the difference in fibre length between the inside and outside of the coils due to change in the spring index, and second they in many cases deviate considerably from the torsion formulas for square bars developed by St. Venant, which practically all authorities on the theory of elasticity agree are correct.

A method of measuring stresses in a helical compression spring is shown in Fig. 1. Here we see an extensometer attached to a helical spring. Since a pure shearing stress of the type existing in helical springs consists of a tension and a compression perpendicular to each other and at 45 degrees to the shearing stress, the extensometer

is in this case placed at an angle of 45 degrees to the axis of the wire of the spring. In a later article, this method will be discussed

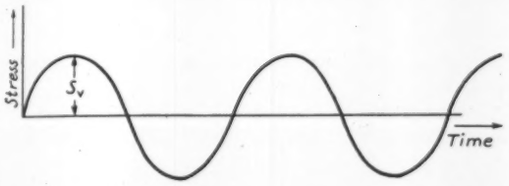


Fig. 2—Stress cycle in ordinary cantilever fatigue test

further, but it may be said that the method shows definitely that the ordinary helical spring formula is incorrect.

We thus see that one reason for the empiricism in spring design is that the fundamental formulas for designing springs often err greatly. More exact formulas, however, are at hand for calculating such cases, so it may be said that at present we can, by the use of more accurate formulas, calculate the stresses and deflections in most mechanical springs with a fair degree of approximation provided the loads are known. When it comes to predicting the consequences of these stresses, i.e., to determine whether or not they will cause failure of the spring, we are still in the dark. In other words, it is a fact that we have little authoritative test data available on the fatigue of springs.

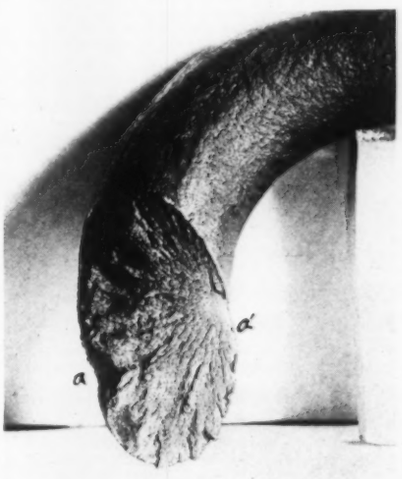


Fig. 3—Coil of spring which failed in service

It is true there are some data available on the fatigue properties of material used for spring steels, but these data have, in most cases, been obtained by means of rotating cantilever tests of polished specimens of spring steel. These tests would be more representative of actual springs provided the surface of springs in service were ground and polished. But in practice springs are usually coiled hot and heat treated, with the result that a fairly rough surface is left. A coil of helical spring which has failed from fatigue is shown in Fig. 3. It is seen that this failure starts at the inside surface of the coil at the point where the maximum stress occurs. It is the typical type of fatigue failure in helical springs which starts from a semicircular nucleus and then proceeds outward.

Since the surfaces of most springs contain small impressions, scratches, scale, etc., it is reasonable to believe that the actual fatigue strength* will be less than would be the case if the surface were ground smooth. This supposition has been confirmed in part by tests on flat spring plates made by the Department of Scientific and Industrial Research in England. The tests show an indicated fatigue strength of around one-third to one-half the value expected from the spring material on the basis of cantilever tests of polished specimens.

A further reason why fatigue tests on cantilever specimens do not apply directly to springs is that the stress cycle in such cases is such that the stress varies between equal positive and negative values, as shown in Fig. 2. In this case, the mean stress is zero, while the variable stress S_v varies between equal plus and minus values. In actual springs, however, the usual stress cycle frequently is as shown at (*a*), Fig. 4. This stress cycle consists in general of a mean stress S_0 on which is superimposed a variable stress S. These mean and variable stresses may be either normal (tension or compression) stresses or shearing stresses. Now it has been found by many fatigue tests on various kinds of steel that the values of the endurance limit under a stress cycle as shown at (*a*), Fig. 4 is different from that which the same material would have under a stress cycle such as shown in Fig. 2. However, in many instances, actual spring designs do not take this fact into account.

Moreover, the springs in practice may be submitted to a constant static stress S_0 on which is superimposed a variable stress S_v which changes continuously in amount. For example a railway car spring

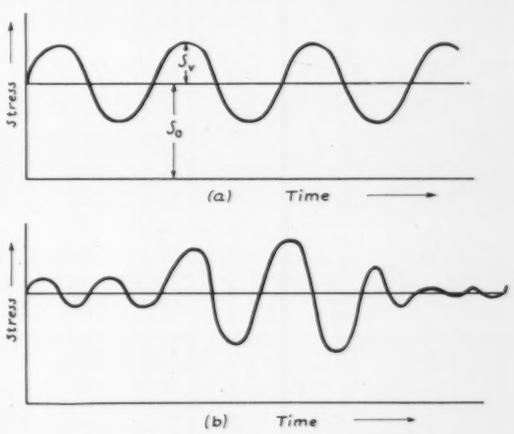


Fig. 4—Stress cycles in ordinary spring applications

*This was suggested by G. M. Eaton, *Transactions*, A. S. S. T., Nov., 1927. See also his discussion, *Transactions*, A. S. M. E. APM-51-24, p. 304.

may be subjected to a static stress S_0 due to the weight of the car. In addition to this stress when the car is in motion, there is an

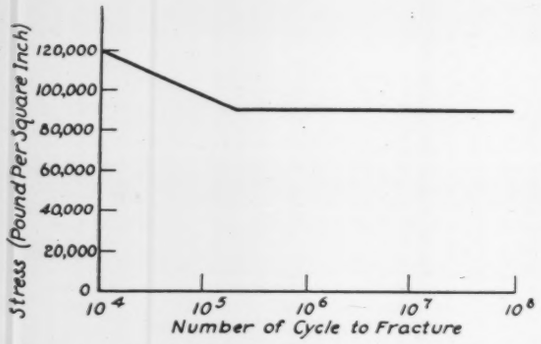


Fig. 5—Typical S-N diagram for spring steel

irregular variable stress superimposed somewhat as shown at (*b*), Fig. 4. At times, the spring may be subject to shocks which cause a high variable stress for an instant. All these facts make for uncertainty in spring design.

Another reason why so much spring design is empirical is that the life of the spring material depends on the number of repetitions of stress. In Fig. 5 is shown a typical curve or S-N diagram representing the endurance of spring material, the ordinates representing stress at failure and the abscissas number of cycles of stress which will just cause failure by fracture. It will be seen that the material lasts for 10,000 cycles at a stress of 120,000 pounds per square inch, while at a stress of 90,000 pounds per square inch the material lasts for 1,000,000 cycles. It is clear, for example, that a spring which has to stand only 10,000 applications of stress can be designed with a considerably higher stress than one which has to stand 1,000,000 applications.

Plastic Flow Affects Actual Stress

A further uncertainty in spring design is the effect of plastic flow in reducing actual stress. Many springs, particularly compression springs, when made are surged or compressed solid so that they take a permanent set. What happens in the spring when this is done may be seen by reference to Fig. 6. The first sketch, given at (*a*), shows the shear stress distribution along a diameter of the cross-section of a helical spring of large index at a load such that the stresses are below the torsional elastic limit. When the spring is surged or compressed so that permanent set occurs the stresses are above the elastic limit and the distribution of stress becomes somewhat as shown at (*b*), Fig. 6. This curve of stress distribution will be similar to a tension test curve of the spring material. On releasing the surging load, residual stresses will be induced somewhat as shown in sketch (*c*). These stresses may be calculated approximately from the condition that the moment of the stresses represented by the triangle *obc* must be equal to the moment of the stresses represented by the area *oadc*. When normal load is again applied to the spring, the resultant stress distribution is somewhat as shown in sketch (*d*). It is clear that by surging the spring we have induced residual stresses of opposite sign which reduce the resultant maximum stress when normal load is applied. An opposite effect would have occurred if the surging had been in a direction opposite to that of the normal load on the spring. In this case the maximum stress in the spring would have been increased.

Similar Action Occurs in Speed Test

Similar effects to these occur in the rotors of large steam turbines which are given an overspeed test. In many cases this results in raising the stresses above the yield point at points near the center of the rotor where the maximum stress occurs. This results in residual stresses of opposite sign when the rotor is stopped. Consequently, at normal speed the stresses are reduced below those which normally would exist if the rotor had not been overspeeded.

Another factor which makes for uncertainty in spring calculations is the residual stress induced by quenching and tempering. These residual stresses are not of much account in springs of small wire sizes but in springs of large wire they are often of importance. This is one reason why lower working stresses must be used in heavy helical springs of large wire than ordinarily would be employed.

A further factor which is seldom considered in spring design is the effect of eccentricity of load-

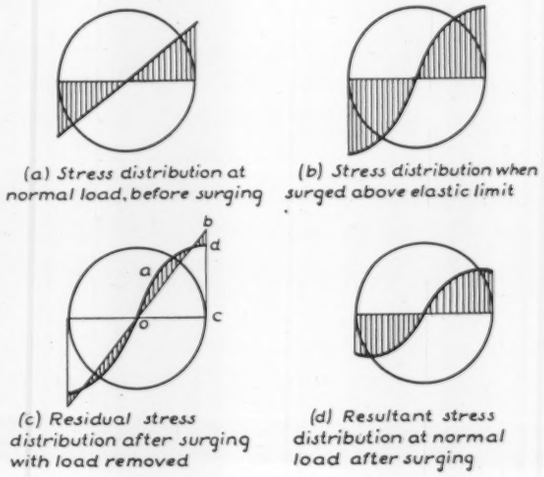

(a) Stress distribution at normal load, before surging
(b) Stress distribution when surged above elastic limit
b
d
a
o
c
(c) Residual stress distribution after surging with load removed
(d) Resultant stress distribution at normal load after surging

Fig. 6—Distribution of stresses over cross section of springs of large index

ing. Consider for example the helical compression spring shown in Fig. 7. Only in exceptional cases will the direction of the resultant load P be exactly central. In the general case this load P will have a slight eccentricity e. The forces acting on the spring may, in accordance with the laws of mechanics, be resolved into an axial load P and a couple Pe. The couple Pe will increase the stresses due to the axial load P on one side of the spring, say at b and decrease those on the opposite side of the spring at a. The result is that in the actual spring, the true stress is higher than that calculated on the basis of an axial load P. This was found to be the case in the compression spring shown in Fig. 1, and on which stresses were taken on opposite sides.

Results of the tests on this spring are given in Fig. 8. One full line represents the stress on one side of the spring; the other line represents the stress on a diametrically opposite side of the spring. It may be seen that the stress on one side is about 13 per cent greater than the stress on the diametrically opposite side because of eccentricity of loading. Unfortunately, in actual springs the amount of eccentricity of the load is one thing which cannot be calculated accurately by any known method since it depends on the condition and shape of the end coils of the spring as well as on the method of loading.

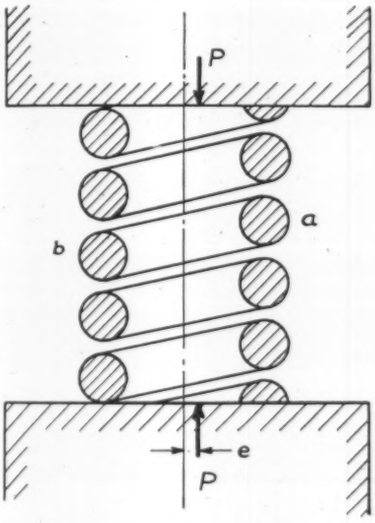


Fig. 7—A helical spring shown under compression. Note the eccentricity of loading

In view of the above considerations, all of which make for more or less uncertainty in spring design, it is not surprising that there is so much empiricism in this important field. In order to place, if possible, the design of mechanical springs on a more exact basis, the author would like to suggest the following general method of determining the working stress in mechanical springs for the consideration of designers.

In a paper on "Factor of Safety and Working Stress" before the American Society of Mechanical Engineers in December, 1929, Soderberg* suggested a general method of determining the working stress for machine parts. As mentioned

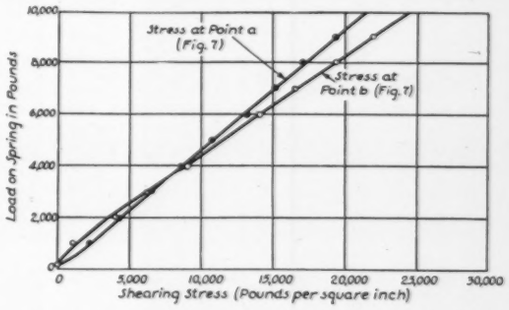


Fig. 8—Results of stress test on helical spring

before, a stress cycle imposed on a machine part may be divided into a constant stress S_o and a variable stress S_v. If tests are made on the material under various values of S_o and S_v it will be found that the limiting values of S_o and S_v which will just cause fatigue failure of the material for various combinations of static and variable stress will be along some curve such as shown in Fig. 9. The ordinates of this curve represent values of variable stress S_v which will just cause failure when superimposed on a static or mean stress S_o as given by the abscissas of the points on the curve.

Where there is no static stress, the variable stress at failure becomes the ordinary endurance limit in reversed stress S_e, so that the curve must intersect the vertical axis at a distance S_e from O. The stress condition represented by any point P consists of a static stress $OA = S_o$ on which is superimposed a variable stress $AP = S_v$. It has been found experimentally that the curve of failure tends to approach the yield point of the material as the variable portion of the stress is decreased. For this reason, the curve of Fig. 9 has been drawn arbitrarily so that it intersects the horizontal co-ordinate axis at the yield point S_y of the material. This procedure has the further justification that working stresses should not exceed the yield point of the material.

Limiting Curve Replaced by Straight Line

Another simplification now is made by replacing this limiting curve of failure by a straight line intersecting the co-ordinate axes at S_e and S_y, thus obtaining the diagram shown in Fig. 10. This procedure is on the safe side for most materials. A line AB then is drawn parallel to the limiting curve CD and having intercepts

*This method also was suggested by Stone, *Transactions*, A. S. M. E. APM-50-16.

S_e/n and S_y/n on the y and x axes respectively, and it is specified by definition that all combinations of static and variable stress which lie on this line will have a factor of safety of n. Thus a point P lying on this line and having values of static and variable stress S_o and S_v respectively will have a factor of safety

$$n = \frac{1}{\frac{S_o}{S_y} + \frac{S_v}{S_e}} \quad \text{.....(1)}$$

This equation may be derived from the geometry of Fig. 10.

For materials not having a well defined yield point, such as most spring steels, it is recommended* to take as the yield point the point where the plastic strain is .2 per cent. This practice is common in Germany and also is used by a considerable number of the large manufacturers in this country.

Applies Method to Valve Spring

As an example of the application of this method, let us take a helical valve spring for automotive work. Assume the spring is designed for a stress of 45,000 pounds per square inch in shear when the valve is open and a stress of 25,000 pounds per square inch when the valve is closed. In this case, the stress cycle shown in Fig. 4 would have $S_{min} = 25{,}000$ and $S_{max} = 45{,}000$. From Fig. 4 the static and variable stresses are:

$$\text{Static stress} = S_o = \frac{S_{max} + S_{min}}{2}$$

$$= \frac{25000 + 45000}{2} = 35{,}000 \text{ pounds per square inch}$$

$$\text{Variable stress} = S_v = \frac{S_{max} - S_{min}}{2}$$

$$= \frac{45000 - 25000}{2} = 10{,}000 \text{ pounds per square inch}$$

Assuming the spring material when in the heat treated condition to have an endurance limit in reversed torsion of 50,000 pounds per square inch and a yield point in torsion** of 80,000 pounds per square inch, we obtain a diagram as shown in Fig. 11. The point where this valve spring is operating will be represented by the point P having an abscissa of 35,000 pounds per square inch and an ordinate of 10,000 pounds per square inch. According to equation (1), the factor of safety as defined will be

$$n = \frac{1}{\frac{S_o}{S_y} + \frac{S_v}{S_e}} = \frac{1}{\frac{35000}{80000} + \frac{10000}{50000}} = 1.55$$

It should be noted that to obtain a true factor of safety, the endurance limit as obtained from fatigue tests on specimens with the surface as in the actual working condition should be used, and not that from machined test specimens.

It also should be noted that the above discussion applies only to springs which are to be stressed a large number of times, such as, for example, valve springs. In practice, however, there are many cases where the springs will be stressed a limited number of times, as, for example, steam chest support springs, springs for circuit-breaker and control mechanisms, etc. In such cases, the working stress may be increased and the same factor of safety be retained. In Fig. 12 there are shown two hypothetical endurance curves, one for a life of 10,000 cycles and the other for a life of 10,000,000 cycles. The curve of endurance for 10,000 cycles means that under these combinations of variable and static stress, failure will occur just at 10,000 cycles of stress. The curve of endurance for 10,000,000 cycles means that it will take this number of cycles to cause failure under combinations of static and variable stress represented by this curve.

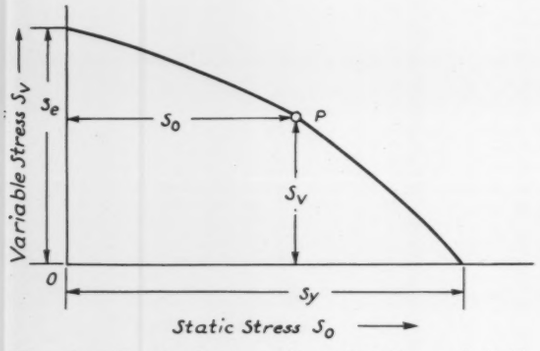


Fig. 9—Typical experimental line of failure for steel

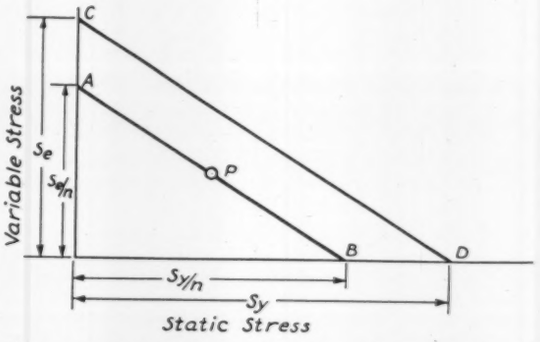


Fig. 10—Method of defining factor of safety for springs

In actual materials, the experimental points in the upper portion of the S-N diagram (Fig. 5) usually are found to be more or less scattered, and it is difficult to get an accurate estimate of the increase in stress possible if the spring is only

*See paper by J. M. Lessells "Concerning the Yield Point in Tension", *Proceedings*, A. S. T. M., 1928, p. 387.

**When the yield point in torsion is not known, an approximation will be had by taking it half the yield point in tension. This will, in general, be on the safe side.

to be stressed a few times. This results because of the considerable variation in actual spring materials in number of cycles to cause failure at stresses above the endurance limit for an infinite number of cycles.

General Hints for the Designer

Machine designers frequently provide a limited amount of space for springs in machines of their design; in other words, they design the rest of the machine and stick in the spring more or less as an afterthought. Since, as a matter of fact, the springs are in reality the most highly stressed members of most machines, and those with probably the least factors of safety, it seems to the

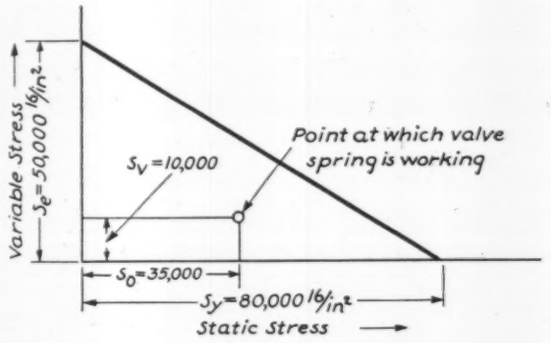


Fig. 11—Assumed endurance diagram of valve spring

author that their design should be given careful consideration.

The designer also should try to design his spring so that the variable portion of the stress is as small as possible, i.e., S_v (Fig. 4) should be as small as possible relative to S_e. This will allow a higher working stress as will be seen by reference to Fig. 9, which shows that a higher stress is required to cause failure if the stress is nearly all static than if it is nearly all variable. A reduction of the amount of variable stress is possible in a great many designs without sacrificing other essential characteristics of the spring, if the proper spring formulas are used.

Another factor which the spring designer should keep in mind is that there is always an unavoidable variation in the size of wire or plate used in making springs. The effect of these variations may be large, especially when it comes to obtaining proper load-deflection characteristics. For example, it is true that in the case of helical springs, a cumulative variation in both coil and wire diameter of only 1 per cent will result in a 7 per cent change in the load deflection characteristic of the spring. Hence it may be necessary to allow the spring manufacturer some leeway in choosing the other spring dimensions to compensate for these unavoidable variations in sizes of commercial wire stock. For example, if the wire for making helical springs happens to be

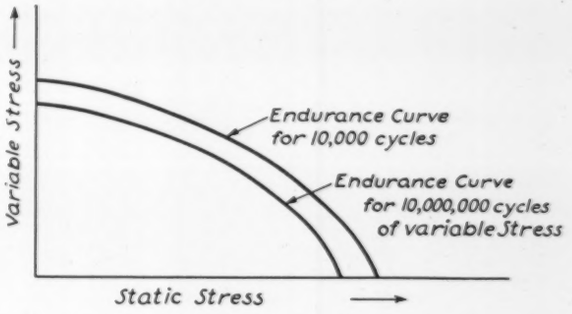

Variable Stress
Endurance Curve for 10,000 cycles
Endurance Curve for 10,000,000 cycles of variable Stress
Static Stress

Fig. 12—Hypothetical endurance diagrams for various numbers of cycles of stress

slightly undersize, the spring manufacturer may be able to compensate for this by slightly reducing the coil diameter. In most cases, this slight reduction in coil diameter would not be detrimental to the operation of the spring. It is clear, however, that for best results there should be close co-operation between the spring designer and spring manufacturer.

Consideration also should be given to the proper choice of the factor of safety. If the consequences of breaking the springs are serious, then a high factor of safety is needed. On the other hand, if a broken spring causes little or no inconvenience or expense, then the designer may be justified by the economics of the situation to lower his factor of safety.

In a later article of this series, some practical design data will be given to show what factors of safety determined as outlined above are actually used in practice. If spring designers could correlate their design data with the endurance properties of the material in a manner similar to that described above, it seems to the author that results of great practical value would be obtained.

Research Engineer To Be Appointed

Indicative of the expansive technical program being followed by the Gray Iron Institute is the authorization, at a recent meeting of the organization's board, of the employment of a full time research engineer to direct the technical activities of the institute. This engineer will be in a position to assist each member with problems confronting him, and it is anticipated his activities will bring him in close touch with many of the design problems connected with the use of gray iron castings in machinery.

How Some Designers Are Considering the Human Element

IT HAS been pointed out, in recent issues of MACHINE DESIGN, that generally speaking there has been a lack of consciousness on the designer's part, of the operator of the machinery he is creating. Instances, however, are being brought to light which indicate the methods adopted to develop certain designs or ideas on the basis of consideration of the worker. It will be found that in this article two examples are cited in which noise elimination plays a major port and that the third example deals with the location of controls on a mechanical shovel in such a position that the operator can remain seated and perform his arduous duties with as little fatigue as would be felt after doing about one-third as much work with an earlier design of machine.

Redesign of a nail machine to incorporate eccentrics instead of cams is the first case to be quoted. Percival S. Thomas, chief draftsman, Sleeper & Hartley, Inc., Worcester, Mass. prepared the following description of design changes in one of this company's machines at the request of the editors of MACHINE DESIGN. It is particularly interesting, in view of the excessive noise prevalent in most nail making shops, and indicates the efforts of designers to overcome the difficulty. Mr. Thomas writes:

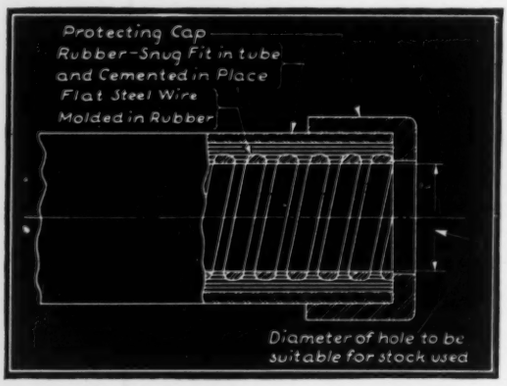


Fig. 1—Method employed for deadening noise of stock in steady rests of automatic screw machines

"Perhaps one of the most noisy machines in existence is the old design nail machine, using cams for actuating the cutters and grippers and a spring actuated heading slide. Cams for actuating these parts are the most convenient from the designers point of view, as the movement of the parts can be timed to a nicety to avoid interference and to give the desired cycle of events.

Noise Often Emanates from Cams

A well designed cam with large roll and pin is without doubt one of the most useful of mechanical movements. But where the rises are sharp or the speed is great they are noisy. This is especially so in the case of high speed open cams, as the return of the actuated parts must be made by spring tension. Unless the spring is strong is proportion to the weight of the parts, the cam roll will not follow the contour from the high point of the cam but will jump from the high point to some place lower down and pound.

"If high speed cams with closed paths are used another fault creeps in. Every time the direction of motion of the follower is reversed, the cam roll comes in contact with the opposite side of the cam path. This causes a reversal in the direction of rotation of the roll, but before it comes up to speed there is a slippage between the surface of the roll and the cam path. This, in high speed work is serious, and has been responsible for the introduction of the conjugate system, in which two cam shafts are used, running in the same direction, with the cam roll between them. The cam paths are reciprocal to one another, and as their peripherial direction is the same as the cam roll, there is no reversal of the cam roll on a reversal of load. This, however, is an expensive construction.

Eccentrics Give True Gravity Motion

"In the S. & H. nail machines (shown in part in Figs. 2 and 3) quietness and ease of action have been attained in a different manner. The use of cranks and eccentrics gives a motion which is a true gravity motion, with a positive return and quietness at any speed. The large bearing

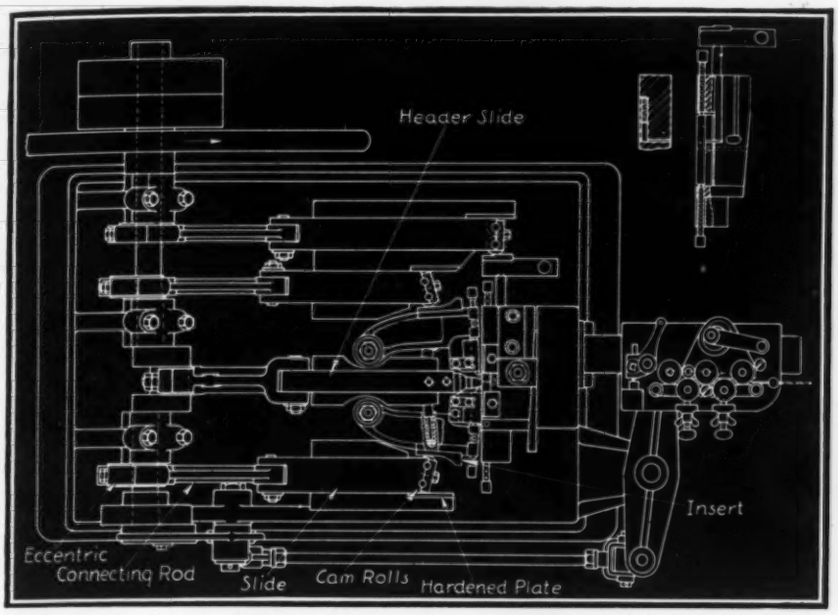


Fig. 2—Plan of nail machine showing eccentrics which replaced cams used on earlier model

surfaces possible in this type of construction make it trouble free and long lived. The motion for the feed mechanism is the only cam operated motion on the drive shaft. This is through a cam roll mounted on a disc on the end of the crank shaft and running in a straight slot in a rocking arm.

"This is an ideal set up for cam operation, as the motion is a true gravity curve, and the cam roll always revolves in the same direction. At the point of reversal of load, the cam roll is traveling lengthwise of the slot in the lever, and picks up the load gently.

"The mechanism which operates the grippers and cutting dies is of a different type, working from an eccentric on the drive shaft to a connecting rod, thence to a slide guided in the frame. In the farther end of the slide are mounted two rolls, being in contact and extending beyond the sides of the slide. The roll on the outside of the slide is supported by a hardened plate set into the guide. The roll on the inside is in contact with a hardened insert in the gripper, or cutter lever, as the case may be. This insert has the necessary cam path to actuate the lever. These rolls have a short travel, and no tendency to slip, and are powerful in taking the final gripping pressure which in the case of large nails and spikes is high.

"The header slide is operated directly by a heavy crank throw and a connecting rod attached to the slide which supports the heading die. This also is a true gravity motion and makes a toggle motion as it goes over the center, at the time of heading, giving great pressure and noiseless operation.

"The machine, after redesigning from the original cam type, showed a great improvement in quietness and ease of operation. It also is much stronger at the vital places, as cam rolls supported on comparatively small studs were replaced by eccentrics and a crank throw which, on a large stiff shaft, eliminated these parts from possible trouble. And the cost of manufacture was not increased greatly by the change."

The second instance of noise elimination covers the application of an idea for deadening the rattling of stock in the steady rests of automatic screw machines. The device, shown in Fig. 1, was developed at the DeVilbiss Co., Toledo, O. A number of the silencers have been in use for about a year and have proved entirely satisfactory in reducing the nerve racking discord emanating from a battery of machines running at high speed. No replacements have been necessary.

As will be seen from the drawing, the silencer

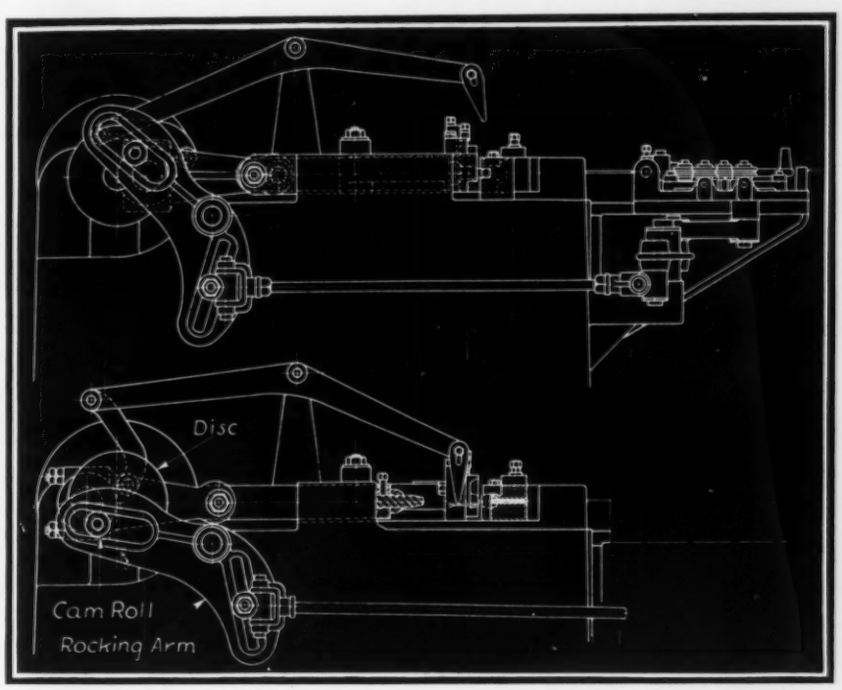


Fig. 3—Two elevations of nail machine. Cam motion for operating feed mechanism is at left

consists of a length of rubber tubing inserted in an outer steel pipe and cemented in position. A coil of flat steel wire is molded in the rubber and forms the bore of the device. Any ringing sound caused by the stock rotating in the tube is deadened effectively by the rubber over the wire.

A silencer of one size will take care of a number of different sizes of stock. The DeVilbiss Co., uses a tube with 1¼-inch bore for stock ⅝ to 1⅛-inch diameter.

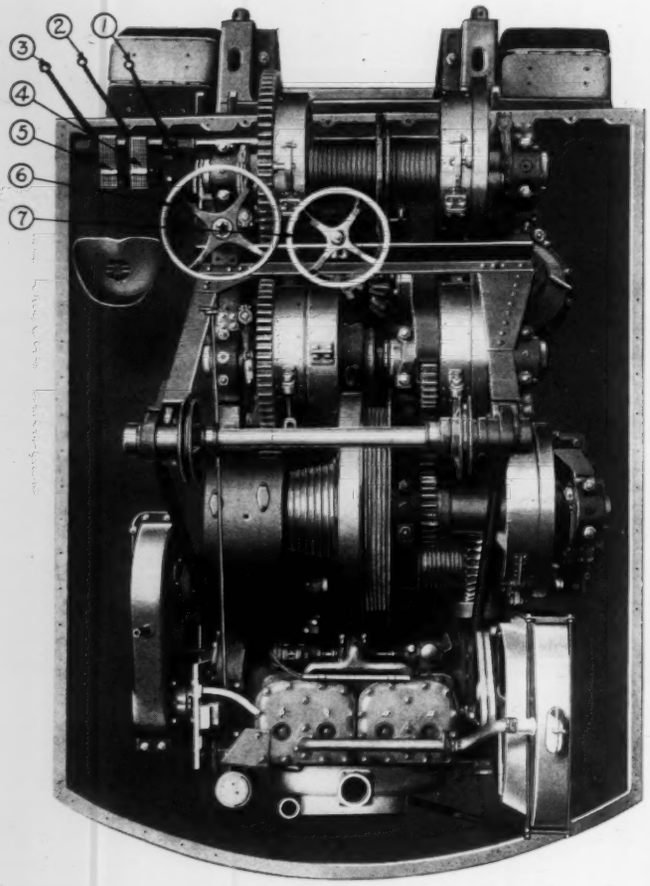


Fig. 4—View of operating platform and mechanism of power shovel showing convenient location

Locating the controls of a machine in such a manner that it is possible for the operator to reach each lever without undue effort has been the aim of John D. Rauch, chief engineer, Ohio Power Shovel Co., Lima, O. Speaking of the redesign of the shovels built by his company Mr. Rauch says:

"There is scarcely another piece of heavy mobile machinery that has as many functions to perform, and is as near human in the performance of these functions as the modern power shovel. The operator of such a machine has so many movements to control at high speed that convenience and ease together with the elimination of all lost motion is of paramount importance.

"It was not so long ago that the operator of such a machine was content to stand upright all day and in many cases step forward and back during each operation owing to the long throw of the levers. Such a shovel equipped with, say, a one yard capacity dipper would have an output of about 500 cubic yards per day of ten hours. The output of the same capacity machine today has been increased to 1500 or more cubic yards per day. This has been accomplished by speeding up all of the operations and cutting to the minimum any useless movements of the operator, together with the assurance of instant response in the machinery to the slightest movement of the operative controls.

"Considering all of the functions that such a machine must be capable of performing to meet modern requirements, its speed of operation has almost been reached so far as the human element is concerned. The operator of such a machine today is kept busy with both hands and both feet and while the main controls have been cut down to three hand levers and two foot brakes, much of the time several of these operations or controls must function simultaneously.

Operator Controls Shovel from Seat

"To meet these conditions with minimum fatigue on the part of the operator he has been provided with a comfortable seat. The levers have been brought within convenient reach of his hands, as shown in Fig. 4, and the length of throw cut down so that it is not necessary for him to change his position in his seat to perform the operations. Brake pedals have been brought up to a position similar to those of an automobile where they can be operated in a sitting position with the least effort.

"In addition to the major operating controls, there are, of course, a number of other functions over which he must have instant control without leaving his seat and in many cases without removing his eyes from the work ahead. These are the engine controls, the self-starter, the locks preventing the machine from rolling on its crawlers during the digging operation and the lock for preventing the revolving cab from drifting or sluing when the machine is traveling; the emergency throw-out, in case it should become necessary to cut off the power from the machinery in case of some accident, the switches for controlling the lights for night operation and the trip mechanism for tripping the dipper in dumping the load. These and many other more or less important features all must be taken into consideration to be within the instant reach or sight of the operator and so far as possible with-

(*Concluded on Page* 44)

Second section of a series of articles dealing with a principle of increasing importance in the design of machinery

Hydraulics in Design

By John P. Ferris

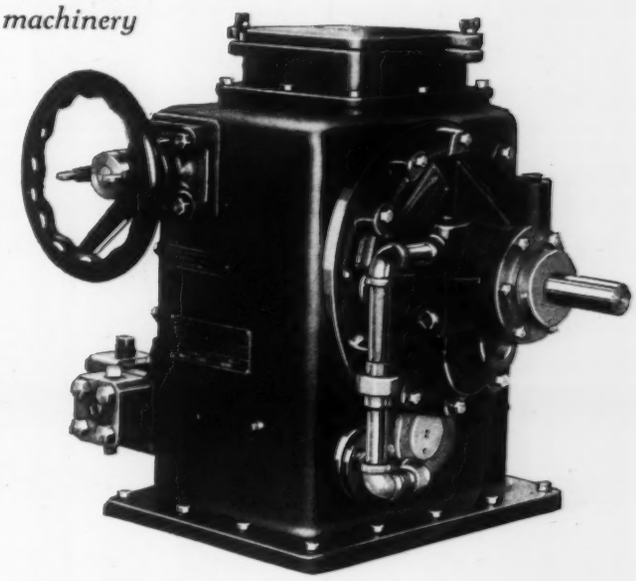


Fig. 2—Modern volumetric pump—multiple plunger, variable displacement

MACHINES on which hydraulic equipment has been used to advantage are so varied that a list of them, while it would suggest applications of the hydraulic method, would not give much assistance in analyzing typical design problems and identifying those for which hydraulic equipment furnishes the best solutions. Consequently I shall attempt in this section to enumerate and illustrate the salient characteristics of hydraulic equipment which have been responsible for its successful use. These characteristics will suggest the specific motions and mechanisms for which hydraulic equipment can be used to advantage.

In many cases, the factors which determine the selection of hydraulic equipment are not only the functions obtainable, but certain properties of the hydraulic method as a whole. Four items in the following list are properties of the method in general, and twelve are characteristics of the motions which can be obtained with various combinations of hydraulic units.

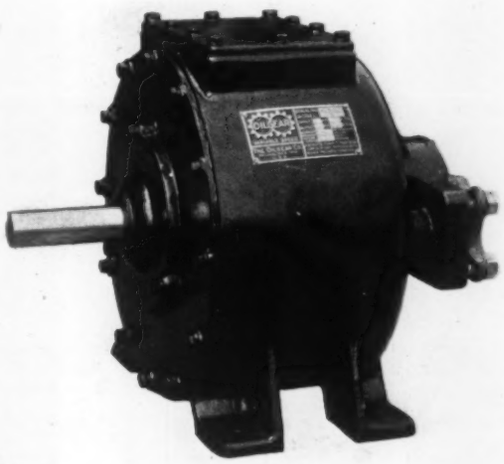


Fig. 1—Modern volumetric motor—multiple plunger, constant displacement

Nine basic systems of hydraulic power transmission were tabulated on page 28 of the March issue. Each of the properties and characteristics described under the following sixteen divisions does not apply equally to all of the nine basic systems of hydraulic power transmission, as the tabulation referred to shows.

Either rotary or reciprocating motions can be obtained in most cases; the sixteen divisions apply in general to either. Reciprocating motions at present are obtained hydraulically more widely than rotary motions, and there also is a wider choice of units for reciprocating motions.

The hydraulic method of power transmission can be used to provide:

A. Accurate and convenient control of speed.
B. Even, positive motion, practically unaffected by load variations.
C. Great flexibility in the location of the units, and in characteristics of the motions obtainable by use of various combinations of units.
D. Large forces with compact and simple parts.
E. Control of force applied.
F. Protection against overloads inherent in the mechanism.
G. Controls by which great variety of functions can be obtained.
H. Continuous indication of load during normal operation, as well as of overloads.
I. Ability to apply large force with no motion, stalling against work or stops without damage to work or mechanism, and with advantage of small expenditure of power

during a stall.

J. Low maintenance cost; excellent lubrication inherent in mechanism.

K. Commercial availability of standard or semistandard units adaptable with a minimum of special design work to a great variety of applications.

L. Cushioned, "gentle" application of forces.

M. Low power consumption.

N. Ability to absorb and dissipate energy harmlessly.

O. Improvement in many processes for reasons not fully understood, but probably resulting from the "cushioning" effect of the fluid medium.

P. Sales Appeal. Irrespective of the specific benefits obtained, the use of hydraulic equipment where it is advantageous indicates to the buyer that the designer of the product is alive to the latest developments.

IT WAS planned originally to complete the series by J. P. Ferris, chief engineer, Oilgear Co., Milwaukee, in this issue. For space considerations, however, the concluding section of this, the second article, will appear in a forthcoming number. In it Mr. Ferris will deal with other important examples and applications of the hydraulic method to machines.

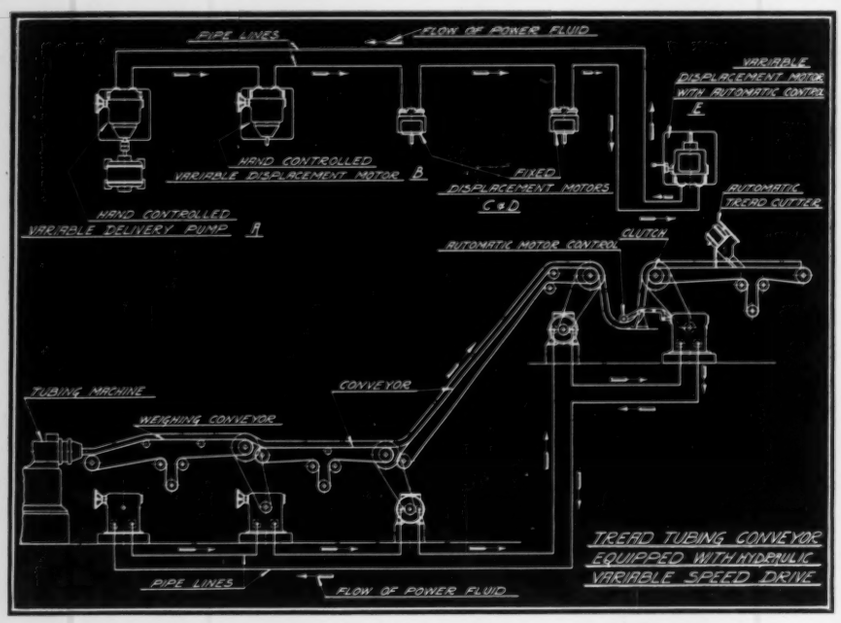


Fig. 3—Diagram of hydraulic drive for tire conveyor

Speed control is of benefit on a large majority of the machines using hydraulic equipment. Fig. 3 is a diagram of a conveyor drive in a tire plant. Several different conveyors are used to carry a rubber strip which is handled successively by each conveyor. They must move at approximately the same speed, but as the first conveyor is mounted on a scale to control the weight of the strip, the length of the rubber changes while on the conveyor and the speeds of two of the conveyors must be varied in relation to those of the other two. Moreover, the lengthening is not by a fixed amount; it varies, and the speed of the last conveyor must change continuously in order to prevent the rubber from "piling up" or being stretched just before the thread cutting process.

The entire system must be started up slowly and its speed changed to suit the rate of production. The speed control is obtained hydraulically by driving the group of conveyors as a unit from the variable delivery pump *A*, of the type shown in Fig. 2. The oil delivered by this pump passes successively through four hydraulic motors *B*, *C*, *D*, and *E*. Motors *C* and *D* are of the constant stroke type shown in Fig. 1. Motors *B* and *E* are of the variable stroke type similar to the pump shown in Fig. 2. As the stroke of the pump unit *A* is changed, the speeds of all the conveyors are changed simultaneously. In order to vary the speeds of the first and last conveyors in the train to suit the variations in the length of the rubber strip, the strokes of the motors *B* and *E* are changed. The rate of flow of oil from the pump is unaffected by these changes in motor stroke, and therefore the other two motors *C* and *D* are unaffected by individual changes in the speeds of motors *B* and *E*. Motor *E* runs at a continually varying speed according to its stroke setting which is regulated automatically by the sag in the loop of rubber just in front of the last conveyor at the thread cutter.

Fig. 4 shows an electric butt welder for joining ends of steel tubing. Butt welding requires that the ends of tubing be advanced toward each other very slowly during the arcing, and then, at the proper moment, jammed together quickly under a large force, about 5000 to 7000 pounds per square inch of cross section for an average tube weld. A hydraulic cylinder moves a carriage on which one of the tubes is clamped. Oil is delivered to this cylinder by a variable delivery volumetric pump. The pump control provides a finely adjustable slow rate of oil flow, pre-set by experiment, a quick shift to full flow, and a reverse motion for returning the carriage. The slow rate is used

Some Machine Uses of Hydraulic Equipment

Fig. 4 (Right)—Butt welding machine fitted with hydraulic table drive, as employed for joining ends of steel tubing

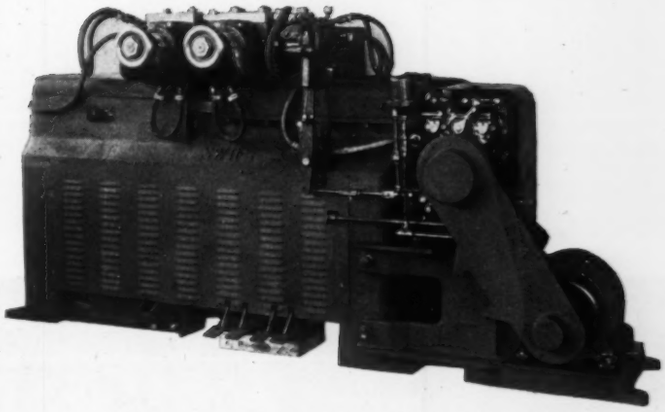


Fig. 7 (Below)—Open-side shaper-planer with hydraulic table drive

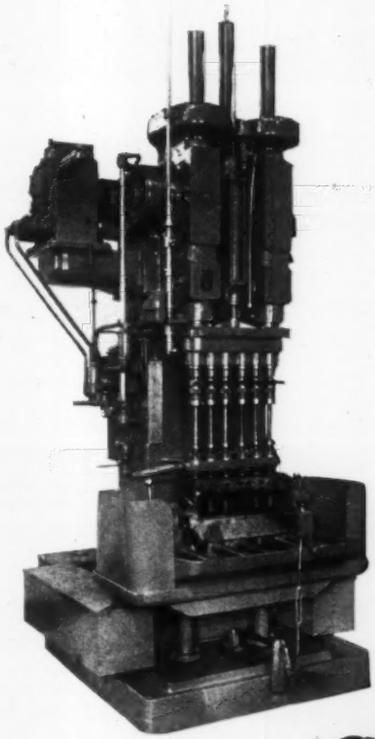
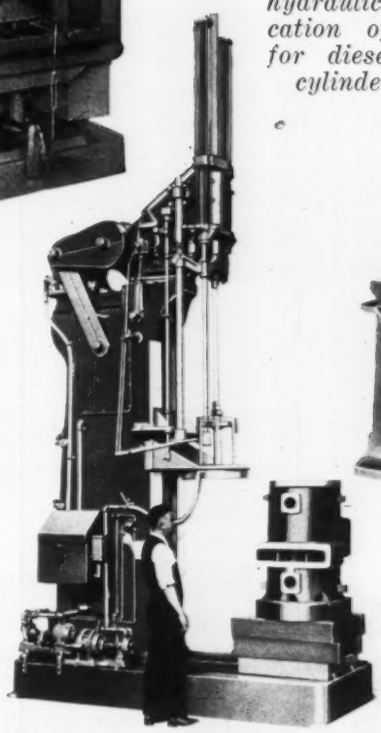


Fig. 5 (Above)—Small honing machine with hydraulic reciprocation of hones; used for finishing automobile engine cylinders, etc.

Fig. 6 (Below, left)—Large honing machine with hydraulic reciprocation of hones; for diesel engine cylinders, etc.



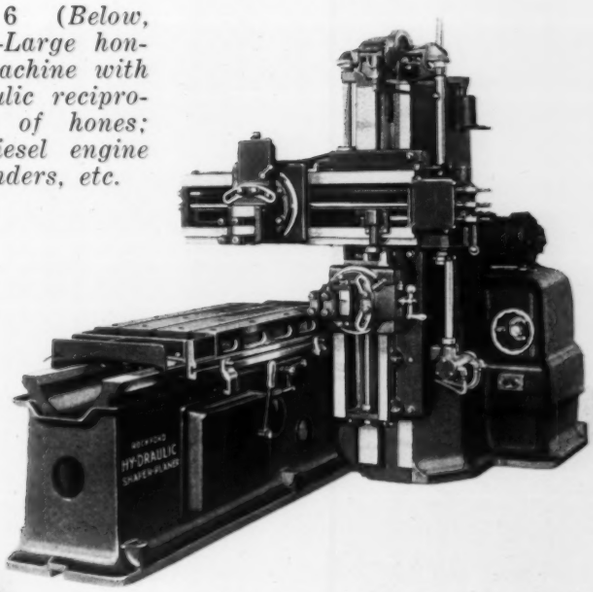
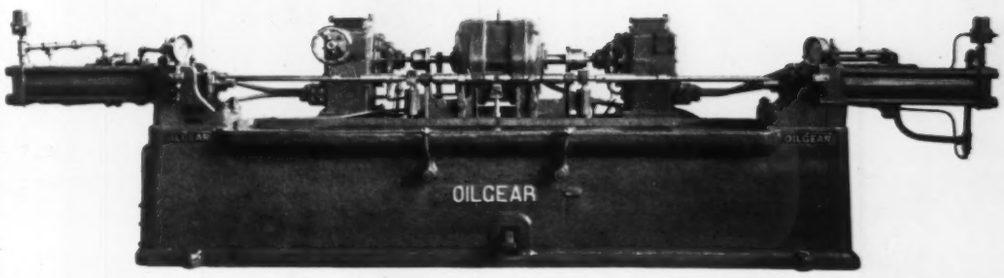


Fig. 8 (Below)—Double-end special horizontal pull-broaching machine. Each end of the machine is equipped with a complete hydraulic unit



for arcing. The operator need not "feel around" for the correct rate; he obtains it instantly by shifting his control handle to the arcing position of the handle, which is approximate only. The control of the pump is so designed that the slow speed is held to close limits in spite of inaccurate location of the main operating lever.

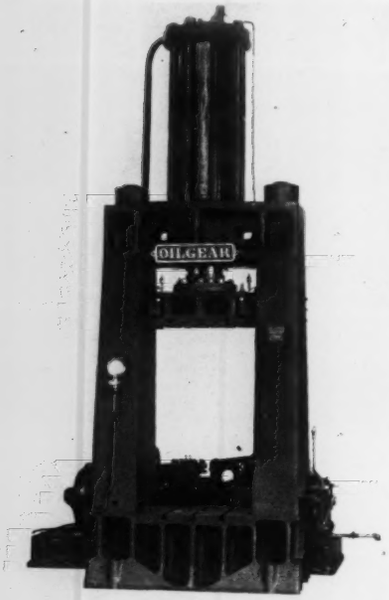


Fig. 9—150-ton hydraulic press for deep drawing of metal. Note the single hand lever at the right of the machine which is employed for controlling the movement of the platen

Figs. 5 and 6 show two vertical honing machines on which the vertical travel for rapidly reciprocating the hones is obtained by hydraulic cylinders receiving oil from variable delivery volumetric pumps. The pump stroke is set to deliver oil at a rate which will give the desired velocity of vertical travel, which must be changed to suit different sizes of holes, materials, etc. This speed is controlled by the rate of flow from the pump, not by throttling in the valve. The valve is used to obtain rapid and smooth reversals of motion, and for starting and stopping the reciprocation.

Fig. 7 shows an open-side planer-shaper on which the table is reciprocated hydraulically. The hydraulic equipment used is the same as on the honing machines already described, except that on the planer the speeds are somewhat lower and the force available for cutting is much higher. In both cases speed control is an important reason for the use of hydraulic equipment.

Fig. 8 shows a double-ended special horizontal pull-broaching machine for broaching out the welding flashes in pressed steel rear axles for automobiles. Each end of the machine is a complete hydraulic broaching machine, although a common control is provided for starting, and both pumps are driven from one motor. At each end of the machine there is an oil cylinder for pulling the broach, and an individual variable stroke volumetric pump which delivers oil to its cylinder. The pump stroke remains set for the desired speed, and starting, stopping and reversing are accomplished by a piston valve. The broaching strokes are started simultaneously by a pedal, and reversed by means of automatic trips. It has been found that the correct speed is important in obtaining good finish on many broaching jobs. In some cases ability to adjust the speed to the work has made it possible to eliminate roughing operations.

Correct Speed Reduces Draws

Fig. 9 shows a 150-ton vertical press designed for deep metal drawing. In metal drawing, working at the proper speed may make it possible to reduce the number of draws for a given amount of reduction. On a crank press the speed changes continually during the stroke, whereas on this type of press it can be maintained at the desired value throughout the entire stroke. It also can be changed during the stroke if desired. The drive is by a variable stroke pump of 65 horsepower capacity piped direct to the cylinder. A single lever is used for starting, stopping, reversing, and regulating the platen speed as desired.

Fig. 11 shows a 50-ton straightening press used for straightening automobile transmission shafts, rear axles, etc. The pedal position gives accurate control of the ram motion and makes it possible to move the ram down just far enough to take the bends out of the work without going too far and thus causing trouble by applying excessive pressure.

Table Speed Can Be Changed

Fig. 10 shows a standard milling machine on which the table is moved hydraulically. A small variable delivery pump is used to control the table speed by metering the outflow from the cylinder which moves the table. The power unit contains two other pumps, one to supply the oil which actually pushes the table as fast as the metering pump will allow it to go, and another for the rapid traverse motions. The ability to control the feeding speed has proved valuable in increasing production and in improving the quality of the work.

It should be added that this machine may be equipped with a device for changing the feeding speed during the cut; with this device it is possible to approximate constant power input into the cut by running the table fast during those parts of a cut where only a small surface is being milled, and slowing it down when a larger surface is presented to the cutters. By means of this feature it also is possible to start and finish the cut slowly, running faster when the cutters

are completely engaged in the work; the shocks to the work and machine which would occur when entering and leaving at maximum speed thus are avoided.

On each of the eight hydraulic applications given in the foregoing the ability to control speed is definitely a requirement of the job, and in most cases it would be impossible to obtain desired speed control in as good or economical a way. On the welder it is possible to vary the speed to suit the exact requirements of a "temperamental" job. On the milling machine it is possible to vary the speed of a moving element while under load. On the straightening press, hydraulics makes it possible for the operator to "feel his way" on a delicate job requiring skilful control during each operation. On the shaper variable speed is valuable not only for obtaining the ideal cutting conditions, but because it furnishes the means of accelerating an inertia load of 4000 pounds up to full speed in about 2 inches of travel smoothly and also without wear and tear on the parts involved.

Provides Facilities for Varying Speed

The drawing press and the welder illustrate another important advantage of variable speed. It enables the designer to build a new machine without exact knowledge of the requirements. On few new machines is it possible to know in advance just what the best or the maximum speed of some critical motion will turn out to be. It depends upon the work, and often on factors beyond the designer's control. The process may be a failure if the designer is too optimistic, and consequently the machine may have to be designed conservatively in order to insure its success. Many machines run for years at half the maximum practicable speed because there is no means of experimenting after they are built in order to find out how much faster they could run successfully. Maximum practicable speeds of broaching are about four times what the authorities thought them to be when all broaching machines were of constant speed. Feeding speeds for drilling cast iron are nearly double what an advanced builder of production drilling machines thought they were. Wherever it is possible to obtain variable speed on a motion, the designer knows that he can experiment with speeds after the machine is built if he has provided variable speed. And if his preconceived ideas don't work out, or if the buyer's specifications change, an expensive redesign and a delay may be avoided by a simple adjustment on the hydraulic drive of the critical motion.

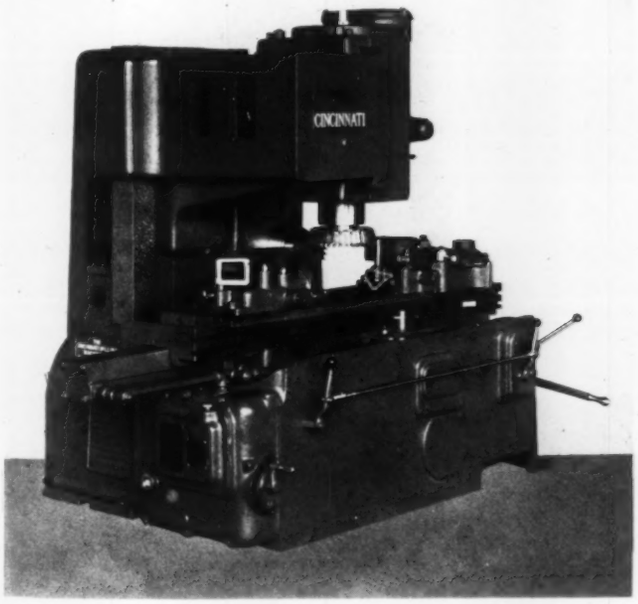


Fig. 10—*Standard milling machine with hydraulic table drive*

Fig. 11—50-*ton hydraulic press with sensitive control. This press is employed for straightening automobile transmission shafts, axles and other similar parts*

Referring again to Fig. 3, it is evident that the successful operation of this closely co-ordinated group of conveyors depends upon the fact that it is possible to obtain with a hydraulic drive not only variable speed, but also a substantially positive drive irrespective of changes in the load. This is characteristic only of the "volumetric" hydraulic systems referred to as Systems 1, 5, and 6 on page 28 of the March issue. (I omit System 2 here because it is not a means of transmitting power continuously.) And where smooth motion is to be obtained, System 1 is not available. This leaves only the arrangements of multiple plunger pump and motor units, of the type which were used for this job. Note that the timing of the constant stroke motor units *C* and *D* depends entirely upon their rotat-

(*Concluded on Page* 53)

Machine Age Is Defended by Leaders of Engineering Profession

A Review of "Toward Civilization" by Charles A. Beard

ABOVE the tumult of a gigantic machine shop arise the voices of a group of engineers in defense of their contributions to this much criticized mechanical age. A long silence has been broken—a silence during which they have listened good-naturedly to philosophers and self-styled humanists heap disparaging and slanderous statements on their heads. Perhaps these engineers were too busy with their own problems to be much concerned with the shouting and protests on the side lines. After all were not these protagonists in the minority?

As an interesting and conclusive answer 16 authors identified with the engineering profession have collaborated in preparing a symposium entitled "Toward Civilization." Under the editorial supervision of Prof. Charles A. Beard, this volume embraces chapters by such personages as Dr. Robert A. Millikan, Dr. Lee de Forest, Dr. Michael Pupin, Mrs. Lillian M. Gilbreth, Dr. Elmer A. Sperry, Richard F. Bach, Thomas D. Campbell, Dr. Harvey N. Davis, Ralph E. Flanders, C. F. Hirshfeld, Dean Dexter S. Kimball, Stephen F. Voorhees, Ralph T. Walker, L. W. Wallace, Dr. William E. Wickenden and Roy V. Wright.

In the introduction Prof. Beard points out that "if, as some critics urge, science and machinery were abandoned, if a few hundred thousand engineers (out of the earth's teeming multitudes) should quit work for good, as Spangler truly says, the whole structure of modern society would come down over our ears." Such facts are startling but in spite of them, there is much written in condemnation of mechanization. Yet withal one feels safe in saying that these self-same critics would be the first to rebel if all comforts wrought by this machine age were to be taken away.

"When scientists and engineers enter upon the larger way," Prof. Beard says, "they will cease to turn on their critics, saying: 'You have abused the instruments we have made.' Although there is truth in the retort, yet upon the designer and builder rests a large part of the responsibility for the choice of place and materials and the methods of the doing."

Reviewing the progress of our machine civilization, Mr. Flanders in his chapter on "The New Age and The New Man," questions: "Dare an engineer and industrialist discuss so intangible, so bodiless a thing as beauty? Why not? The poet and the artist have not hesitated to discuss industrialism. The industrialist is no further afield in thinking and writing of Beauty."

With the will of a true crusader Dr. Sperry sets out to give his impressions and findings in chapter three, "The Spirit of Invention in Industrial Civilization." "In the very tempo of industry" he sees the imperative need for "the venturesome spirit of invention." Not only is this power able to conceive machines but "it is equally useful in any attack on the evils of our civilization, such as congestion of population, traffic snarls, ugly structures, badly planned cities, and ill-adjusted industrial relations."

There is a ringing truth in his statement that "if modern civilization is troubled in its soul about the so-called evils of the machine, perhaps it is because it has not thought its way through its own problems and presented them effectively to inventive minds. * * * Rather than make scapegoats of engineers, it might be wiser to lay before them a program calling for invention as well as mere construction."

Leafing on through the volume one's interest becomes more intensified as revelation after revelation is unfolded to prove the cause of the en-

gineer and particularly the designer and his stupendous task. "Power," a chapter by C. F. Hirshfeld and another on "Transportation," by Roy V. Wright, keep up the pace. Dean Kimball assures us that "This criticism of modern industry is well taken, and there is still need for preaching the necessity and value of cleanliness,

"I HAVE no question that the more and more complete mechanization of production that is under way is, on the whole, opening larger and larger opportunities in spirit and culture for the masses of mankind."—Harvey N. Davis, president, Stevens Institute of Technology.

good appearance, reduction of noise, the prevention of accidents and more pleasant surroundings inside and outside of the factory."

Agriculture and its role in a machine age is extolled by Thomas D. Campbell. "The biggest industrial opportunity in the United States today is in agriculture, and the broadest field for the technical man is in agricultural engineering," he says. L. W. Wallace writing "Engineering in Government," shows that engineering technique and the results thereof have permeated the entire structure of the Federal government.

Designers will find the chapter by Richard F. Bach particularly fitting and in accord with much that has been written in reference to the new trend in style of machines. "Art in the Market Place," contains such passages as: "Competition is at present the strongest ally of design in

"WHEN a thousand years hence the oil and coal are gone, it will be the scientist and the engineer who will capture with a solar engine of some kind the sun's fire and do man's work with it."—Dr. Robert A. Millikan, retiring president of the American Association for the Advancement of Science.

its efforts to rehabilitate itself, for competitors are using art as a big gun in their attacks on 'consumer preference.' Then there is the further reliance to be found in the growing body of public opinion in favor of good design."

Only highlights and not all of those can be touched in this limited space. Other chapters not already mentioned include: "Science Lights the Torch," by Robert A. Millikan; "Communication," by Dr. Lee de Forest. "The Machine and Architecture," by Stephen F. Voorhees and Ralph T. Walker; "Work and Leisure," by Mrs. Lillian M. Gilbreth; "Education and the New Age," by Dr. William E. Wickenden; "Machine Industry and Idealism," by Michael Pupin; and "The Spirit of Culture under the Machine," by Harvey N. Davis.

In this summary at the end of the book Prof. Beard says: "Besides showing that the new drama of mankind has just opened, our authors demonstrate that the spirit of engineering is rationality, a faith in the power of the scientific method to undo what should never have been done and to realize whatever human imagination may suggest in the way of material and social arrangements.

"It is difficult to discover any value ardently desired by the critics of machine civilization which these engineers do not likewise desire.*** Is it anything covered by the term humanity—fair dealing, toleration, freedom from pain and suffering, relief of misery, sucor for them that are hungry and athirst? * * * They propose to use the engines of science and invention to fortify, speed up and multiply the agencies of humanity."

With a purpose so humanistic, what more can posterity ask of the engineer? Here is a collection of works that every designer will find worth reading.

"Toward Civilization" is published by Longmans, Green & Co., New York, and will be supplied by MACHINE DESIGN for $3.00 plus 15 cents postage.

AMONG OTHER BOOKS RECEIVED

Practical Japanning and Enameling, by William J. Miskella, M. E.; 256 pages; published by Finishing Research Laboratories Inc., Chicago, and supplied by MACHINE DESIGN for $3.50 plus 15 cents postage.

Practical Automotive Lacquering, by William J. Miskella, M. E.; 190 pages; published by Finishing Laboratories Inc., Chicago, and supplied by MACHINE DESIGN for $3.50 plus 15 cents postage.

The Aluminum Industry, Vol. 1, covering *Aluminum and Its Production*, Vol. 2, covering *Aluminum Products and Their Fabrication*, by Junius David Edwards, Francis C. Frary and Dr. Zay Jeffries; published by McGraw-Hill Book Co. Inc., New York, and supplied by MACHINE DESIGN for $12.00 plus 30 cents postage.

Further information concerning these books will be furnished by the editors of MACHINE DESIGN on request of readers.

Can Metal Stampings Be Employed?

By Phil Kempter

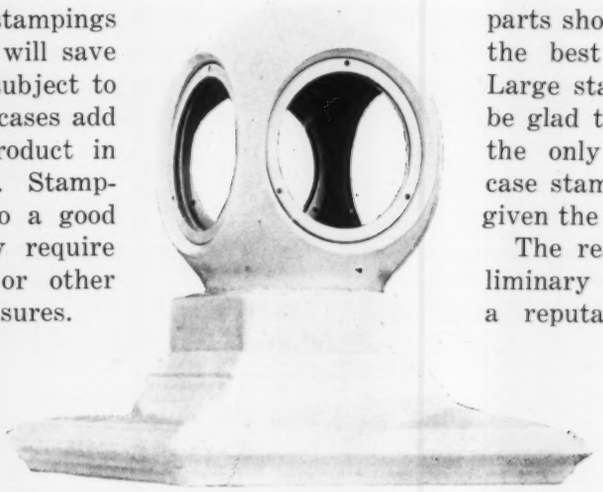
DETERMINING whether stampings would be practicable—Elements entering into design—Is low price a governing factor? These are some of the important features in the article which appears on the accompanying pages. The author is works manager of Geuder, Paeschke & Frey Co., Milwaukee.

A QUESTION which has been asked by executives in many industries when considering changes in design of standard products or the development of new devices is contained in the title of this article.

The purpose of the author is to endeavor to point out to such executives the many advantages of pressed metal parts, and at the same time to discuss their limitations.

Among the advantages which are emphasized in connection with the possibility of using metal stampings are, first, saving in weight with a consequent saving in freight cost from the plant of the supplier to the plant of the purchaser. This saving may be added to the saving realized on account of the comparative low cost of stampings. Upon arrival of the material at his plant, the purchaser will find additional savings in the fact that properly made stampings will require no machining, will save in assembly time, are not subject to breakage, and will in most cases add to the strength of the product in which they are incorporated. Stampings are also susceptible to a good finish at low cost as they require no filling, rubbing down or other expensive preparatory measures.

Having considered the advantages which generally may be claimed for stampings, the next step to be considered is the manner in which they can be utilized in the particular case in mind. The service to which the part is to be adapted usually will govern the decision regarding the feasibility of stampings. In the early days of the stamping industry, only the simplest forms of work could be produced; but today, owing to wide experience of some of the concerns in the business, it is possible to produce difficult stampings which in past years would have been considered out of the question. Further, the extensive use of welding methods has made practicable the production of stamped welded assemblies to meet rather complicated conditions.



A welded assembly familiar to every motorist

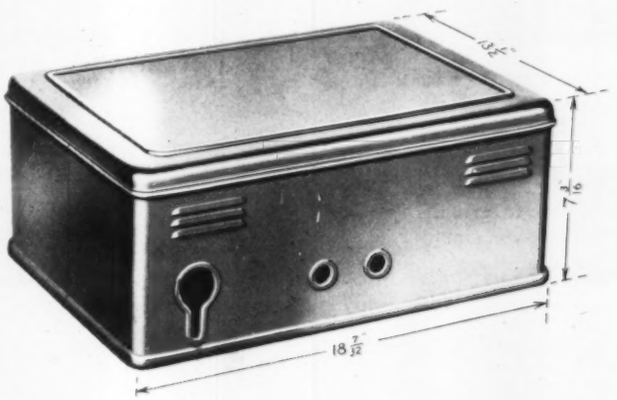
Utilizing Available Engineering Service

Would-be users of stampings therefore would do well to select a stamping company with a record of accomplishment and consult it as to how features in the design of parts should be treated in order that the best results may be secured. Large stampings manufacturers will be glad to give service of this kind, the only obligation being that in case stampings are adopted, they be given the opportunity to do the work.

The reason for suggesting a preliminary working arrangement with a reputable stamping concern, is that in the long run the prospective stampings buyer will save money by so doing. Otherwise he might proceed with the design of stampings without a sufficient

knowledge of the manufacturing end of the business, might not make full utilization of manufacturing possibilities on the one hand or might, on the other hand, incorporate in his design features which are not practical from a manufacturing standpoint. He would then find, on sending out inquiries, that some companies would quote on the work as designed and there probably would be a wide difference in the quotations received. These could be accounted for by the fact that some concerns who would bid on the work, would not appreciate the difficulties involved in the design and would submit an unintelligent proposal; other concerns, understanding the difficulties involved, would quote higher prices. Naturally, the tendency on the part of the buyer would be to place business with the low bidder which might cause serious delay and complications in the eventual production of the parts.

Employment of such engineering service as is

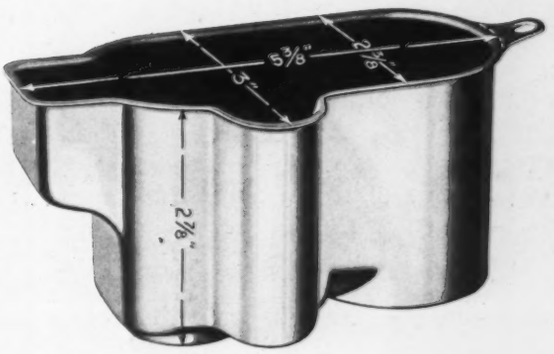


Interchangeability of parts to save assembly time and assure presentable appearance were essentials in this radio cabinet

provided by the larger stamping companies, as suggested, might appear at first glance to be a reversed method of purchasing; that is, selecting the company with which the business will be placed and then having that company help to work out the details would not appeal to a great many purchasing agents who would prefer to have details worked out first, even though running the risk of a less practicable design, and later determine upon the supplier who should be awarded the order, based entirely on prices submitted.

Results Are Beneficial to Buyer

However, in the long run the above suggested method would prove the more economical, in that it would assure a satisfactory product which would accomplish the purpose intended, would be more easily assembled and would be made of materials suitable to take the finish desired.

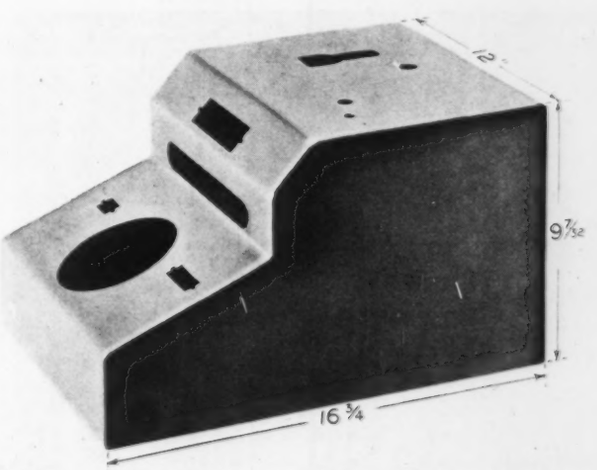


Unusually difficult stamping free of wrinkles though complicated. Weight was saved and machining eliminated in this carburetor body

It is customary, after the preliminary work is accomplished, for the supplier to quote on product and tools separately. In case the buyer has done all of his own designing and sends out the inquiry to several stamping concerns for prices he should, upon receipt of quotations, take into consideration a number of things besides the lowest price for product and the separate cost on tools.

It is possible with stampings to produce most parts with smooth corners and smooth contour by the employment of high-grade tools or to produce similar parts with wrinkles and other blemishes by the use of poorly made tools or through lack of experience. Naturally, such variations in the product which will be secured, would be indicated to the experienced buyer in the price quoted. For some work the poorer quality of stamping might be acceptable. In other classes of work, where the stamping will be in a conspicuous position, such blemishes could not be hidden by any finish put on them.

There are instances, as in the case of housings for adding machines, time clocks, vending ma-

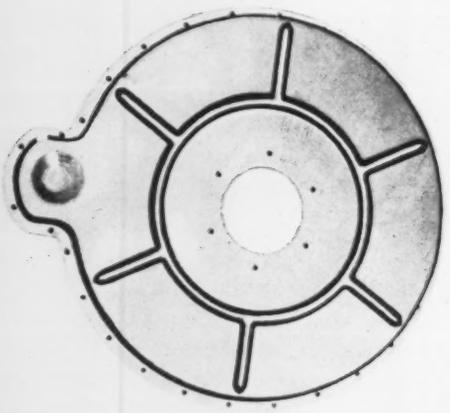


Some companies considered it impossible to manufacture the one-piece clock case shown above

chines, etc., where castings or wooden cases have been replaced by steel stampings. Such parts must be finished with a surface which will take either lacquer, baked enamel or porcelain enamel and shall, when the finish is applied, present a pleasing, unscarred, uniform surface without waves or wrinkles. Such parts can be produced only by properly made tools coupled with experience in their use.

Limitations in Quantity Requirements

Another condition governing the determination upon the use of stampings is the question of probable maximum quantity which may be required. Where the quantity is small the cost of the tools in many cases would not be warranted, but where the quantity is large the cost of tools, as between the bid of one supplier or another, actually is a minor consideration. The main consideration is the quality of product to be secured from the tools as to appearance, uniformity in size and interchangeability. Also, the price of the product as between the bid of one supplier and another may be of minor consideration where a quality job is to be produced.



A more generally used type of stamping employed for machine guards to enclose gearing

In summing up, it appears important again to emphasize the need, on the part of anyone inexperienced in stampings, to secure the cooperation of a concern having a wide experience and a reputation for producing quality work.

Increasing employment of the "electric eye" is demonstrated by the fact it now is used for determining the temperature of steel under manufacture, counting the number of people entering a building, sorting packages, operating fire extinguishers and turning on lights.

Urges Co-operation Between Foundry and Designers

THAT the production of steel castings involves more than the actual supplying of the parts and should be considered distinctly as an engineering service was brought out forcibly at a recent meeting of the Steel Founders' Society of America held in St. Louis.

F. J. Stanley and others present advocated even greater co-operation with designers and engineers—lending assistance and giving such suggestions as will enable the user to obtain the maximum advantage and service from the castings he buys.

Outlining some of the sweeping changes which have turned things upside down in the steel industry, Granville P. Rogers, managing director of the society, made some comments in his address which are of particular interest to the engineer connected with design.

"New methods and processes," Mr. Rogers said, "are revolutionizing operations which have been considered standard ever since the commercial production of steel.

"A whole new family of alloys, which have followed the stainless steel patent of Harry Brearley in England in 1916 have made their appearance during the past few years. Every year, almost every month sees the advent of some new and important combination of metals—and the end is not yet.

"Ingots can now be cast in centrifugal molds. Continuous sheet mills are in full operation. Combined drawing and rolling action feature the production of sheet steel by a new process.

"High speed electrical welding of tubes is now a reality, with at least four different processes in use. Low temperature ore reduction is on the near horizon.

How Some Designers Are Considering the Human Element

(*Concluded from Page* 34)

out distracting his attention from the work the machine is doing.

"The success with which this has been accomplished is attested by the fact that the operator still continues to work eight to ten hours per day continuously, increasing the output of the machine three fold, and is less fatigued at the end of his shift than under the conditions formerly met with."

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Considering the Human Element

To The Editor:

I HAVE looked over the article "The Time Is Ripe for Engineers to Consider the Human Factor," which was published in your February issue, and I believe that you are on the trail of an important feature in machine design which has been seriously neglected in the past. I have not the least doubt that consistent hammering on this idea will cause a lot of discussion in the machine design profession.

I. C. KELLER,
Chicago.

Suggests Locating Controls by Trial

To The Editor:

LOCATING controls and making them conveniently accessible is a hard job. However, in our drafting-room, where it is proved time and again that there is nothing more complicated than the cockpit of an airplane, where all the various controls and instruments must be located conventiently to the pilot for operation and observation even though space requirements are exceptionally limited, we make a wooden mock-up of all the controls and installation out of scrap lumber, plywood, paper, in fact anything handy, and then have a pilot sit in the pilot's seat and comment upon the accessibility of the various controls. We modify the installation in accordance with his suggestions, until he is finally satisfied, and then proceed to make the drawings.

By following this method we often are enabled to make some improvements that had not suggested themselves in our layouts. The pilot also may be able to give us a few suggestions which are incorporated in the final design.

This idea can be used in designing intricate machines and in locating controls on such machines for accessibility and convenience of the customer's operator. All that will be involved is the changing of a few pieces of wood, which is much more pleasant and economical than completing, and later being compelled to change, a finished drawing.

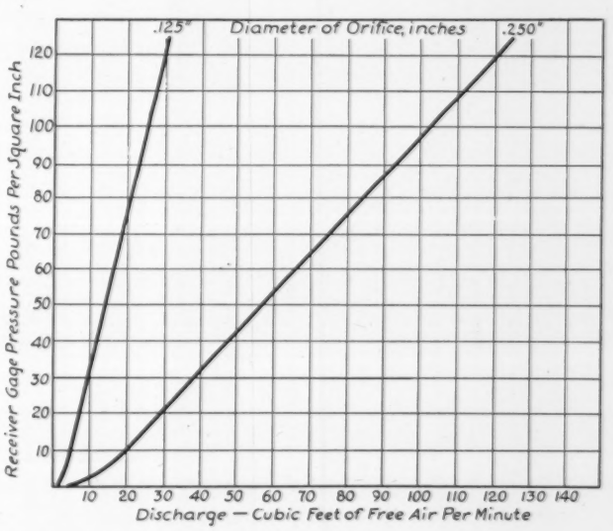
GEORGE H. GUNN,
Philadelphia.

Calculating Consumption of Air

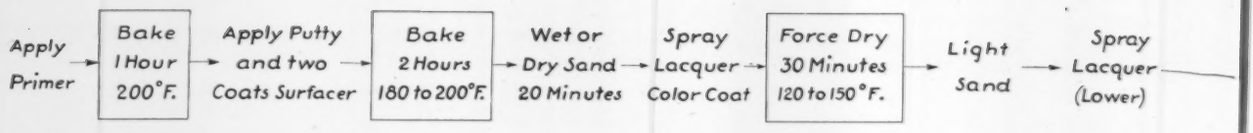
To the Editor:

IN CONNECTION with the production of small sheet metal parts on punch presses, air affords an ideal means of ejecting the work.

When a large number of air applications of this nature are used, it often is necessary to calculate the consumption of air. This requires considerable time, and when completed is at its best only approximate, as experiments on energy losses made by Josse and Christlein with De Faval nozzles would indicate. The accompanying chart will be found quite accurate and has been checked by the writer against data compiled with a water-displacement meter.



GEORGE T. CHAPMAN,
Detroit.


Apply Primer
Bake 1 Hour 200°F.
Apply Putty and two Coats Surfacer
Bake 2 Hours 180 to 200°F.
Wet or Dry Sand 20 Minutes
Spray Lacquer Color Coat
Force Dry 30 Minutes 120 to 150°F.
Light Sand
Spray Lacquer (Lower)

Evolution in Finishing Processes Worthy of Designers Study

By M. J. Callahan

IN THE past ten years probably no product of modern industry has demanded more profound changes in the materials and processes used in its construction than has the automobile. Finishes and their methods of application have been no exception to this general rule; in fact, the changes introduced have savored more of revolution than of evolution. This becomes more apparent when one considers that in the brief space of ten years the basic ingredient of body finishes has been changed to one of radically different chemical nature, that an entirely new technique of application has developed, that entirely new chemicals have been synthesized for use in these new finishes, and that with this new art and change have resulted great economies to the manufacturer as well as benefit of increased service and utility to the owner.

All finishes must be easy of application and adaptable to rapid production methods. They should add beauty and style to the parts to which they are applied. They must retain these characteristics unchanged under severe conditions of exposure and service.

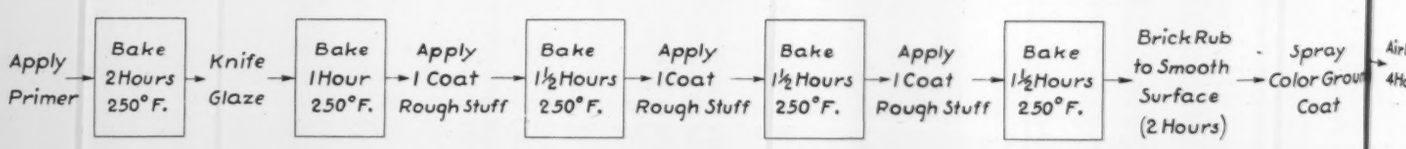
Body Finish Is Primary Consideration

Of the different types of finishes, the body finish is of first importance. Second to the interest of an owner in the mechanical details of his machine comes his desire for a beautiful appearance. He is interested in obtaining a smooth finish of high luster which will be retained for the longest possible period over the useful life of his machine. Ten years ago, surfacing coats were in general satisfactory both as to working qualities and service durability, but color coats were neither satisfactory to the ultimate owner of the car nor to the manufacturer. It was inevitable, therefore, that in this period, the first big step in the evolution of automobile finishes should have occurred with a change in color coats of the body finish. This step was the introduction in 1923 of color coats of quick drying finishes or lacquers based on cellulose nitrate.

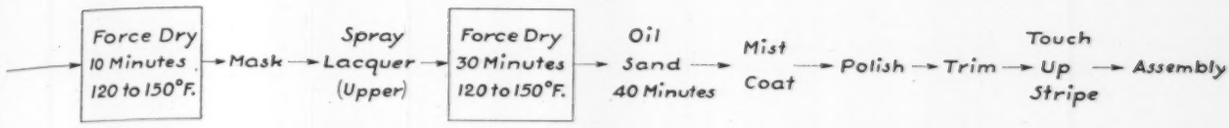
Fig. 1 *(Below)—Flow sheet, body finishing prior to* 1923

Total operating time, days	4 to 9
Total hours operating	40
Operating space, 300 bodies per day, square feet	100,000
Bodies in production per day	1500
Rejects (painting defects), per cent	15 to 20

Fig. 1 is a flow sheet of the method used in finishing bodies of a medium-priced automobile just prior to the introduction of lacquer color coats. The large number of baking operations is notable. These were carried out in so-called box-type ovens. The bodies were all handled on individual trucks requiring hand labor. A large percentage of marred finishes resulted from this method of handling and the difficulty of effecting repairs even of minor character was great. The consequence was that extra floor


Apply Primer
Bake 2 Hours 250°F.
Knife Glaze
Bake 1 Hour 250°F.
Apply 1 Coat Rough Stuff
Bake 1½ Hours 250°F.
Apply 1 Coat Rough Stuff
Bake 1½ Hours 250°F.
Apply 1 Coat Rough Stuff
Bake 1½ Hours 250°F.
Brick Rub to Smooth Surface (2 Hours)
Spray Color Coat

WHILE the accompanying article is based primarily on finishing methods as employed in the automotive industry, much information contained in it can be applied to advantage in the design and production of machinery in general. The article is an abstract of a paper presented by Mr. Callahan before a meeting of the American Society for Testing Materials held at Detroit, March 19.



space and extra capitalization was tied up in repair work only. In some of the finishing shops where lower priced automobiles were produced, a much more rapid system was in force. Primed bodies were flow coated with two coats of black varnish with a baking operation following each flow coat. In such shops the chain system of handling bodies was in force and notable economies in production costs and space had been obtained.

Flow Sheets Indicate Vast Change

Fig. 2 is a flow sheet of the method now in use in modern automobile body finishing plants and is generalized from operating data from nine body plants. When the two flow sheets are compared, the tremendous changes that have occurred in body finishing methods are at once apparent. In the first place the time cycle of operations has been shortened so that the body now can be taken from the bare steel to the finished trimmed job in one working day of aproximately ten hours. The number of baking operations has been decreased, and particularly in the case of the color coats the temperature of baking has been decreased. The moving chain assembly method of operation has been applied to the whole operation of finishing with the resultant economy in space, labor for handling, etc. It will be noted that the trimming now is included with the finishing, and that the final operation is more in the nature of a touch-up and final polishing before turning the body over to the assembly line.

The statement has been made by one successful body engineer that without the use of lacquer mass production of this great number of machines would have been impossible. Everyone familiar with the industry realizes the difficulties that existed with the use of finishes based on oleoresinous paints and varnishes, such as their lack of proper drying, their lack of resistance to marring, and their lack of ultimate durability under conditions of service.

In comparing Figs. 1 and 2, the point of greatest interest is that actually less floor space is required for finishing bodies in 1929 than in

Total operating time, days	1
Total hours operating	9.5
Operating space, 450 bodies per day, square feet	60,000
Bodies in production per day	400
Rejects (painting defects), per cent	1

Fig. 2 (Above)—Flow sheet, modern automobile finishing

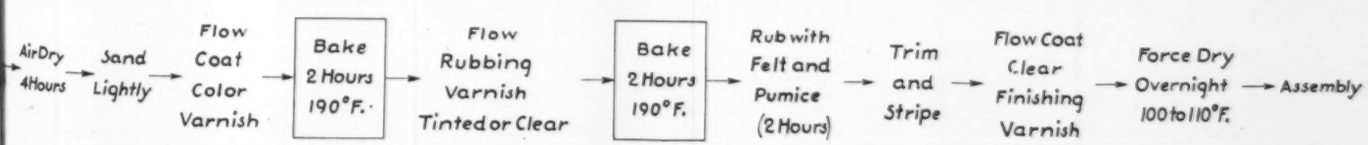
1922, although the production nearly doubled. The tremendous cut in car inventory during manufacturing also represents a further capitalization decrease.

Not only has the adoption of lacquer contributed marked changes and economies in the production end of the automotive industry, but it has also opened new fields to the design and sales departments. As mentioned previously the older methods of finishing bodies had arbitrarily limited their design and treatment. With the exception of the higher priced cars, body design in 1922 was limited largely to open models. This was due in large measure to the necessity of fitting the design to production finishing methods, particularly to flow coating.

Sales Effects and Consumer Benefits

Hand in hand with this development in design has gone the use of color in sales work. A new type of service called color advisory service has developed, whose function is to try to stimulate sales through the selection of properly harmonizing color combinations, which not only will be subtly attractive to the eye, but which will actually serve to effect change in appearance.

Not the least important of the changes introduced by the adoption of lacquer has been the durability imparted to the automobile finish under conditions of service. In contrast to the older finishes based on oleoresinous paints and varnishes, a modern lacquer properly applied will not change color, crack, craze, or peel during the life of the car. Some disintegration of the surface occurs during service, but the original luster and brillancy can be restored by a slight amount of rubbing with a polish containing mild abrasive.



MACHINE DESIGN

Are Opportunities Broadening?

Editorial

OCCASIONALLY some of the younger members of the engineering profession are heard to remark that in the present industrial era fewer opportunities are afforded for invention. Mentally they review all the important achievements in the eighteenth and nineteenth centuries and are impressed that these represent a higher order of pure invention than is embraced in the wonderful accomplishments of the present century. To them the work of Watt, Stephenson, Faraday, Fulton, Whitney and others is marked with elements of originality to a greater extent than the work of twentieth century engineers.

PERHAPS there is some basis for this reasoning. Notwithstanding the fact that an abundance of original discovery has been witnessed since 1900, it is true that opportunities for the average individual in design work lie more in application of well known mechanical principles than in pure invention as demonstrated by some of the earlier inventors. It is apparent from everyday developments that the possibilities of some of the time-proved mechanical elements such as the cam, hydraulic and pneumatic movements, screw, etc., are far from being exhausted. For example, witness the numerous recent developments in speed reducers. All of these employ one or more old principles, but in arrangement and conception the reducers are different from old designs. In these and other new mechanical developments the work of the designer has been characterized by ingenuity in applying old ideas, rather than in bringing forth new principles.

THE reason for this is clear. New materials constantly are becoming available. New requirements in machines frequently call for the use of ideas that did not work satisfactorily under previous machine demands. It can be seen, therefore, that the designer today has greater leeway than ever before in selecting from a wide range of metals, processes and principles the combination best suited to his needs. Also it is clear that if he is to be most effective in his choice of these resources he must be informed of what is going on, not only in his own field but in every branch of engineering which touches on machine design.

THIS explanation reveals the motive which has actuated the editors of MACHINE DESIGN in publishing so much material on the fundamental principles of design and in presenting a perspective of design trends in the various branches of design activity. We contend that the rapid advance of design rests largely upon the easy exchange of experience from one field to another. And we hope and believe that in facilitating this interchange MACHINE DESIGN is engaged in a mission of great possibilities. By the same token we are certain that no engineer in design work can afford to ignore what is being done by his contemporaries in fields beyond his own.

Humanistic Engineering

PROMINENT engineers from various countries presented monographs at the recent fiftieth anniversary of the American Society of Mechanical Engineers. In general, progress during the past 50 years formed the basis for each speaker's address. But to the close observer it was evident that in the minds of several another thought was present—the question of the degree to which man has benefited by advances made recently. A number definitely appeared to be of the opinion that there remained a great work to be done from the humanistic standpoint. Following this thought it seems desirable, for instance, that engineers train themselves by consent to look upon competition not as a struggle to find ways and means of getting the most work out of producers, but as a race to provide equipment which will function more rapidly, accurately and efficiently with the least expenditure, in its operation, of mental effort, brute strength and energy.

George Stephenson and His Locomotive

Great Moments in Machine Design—Ninth of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind.

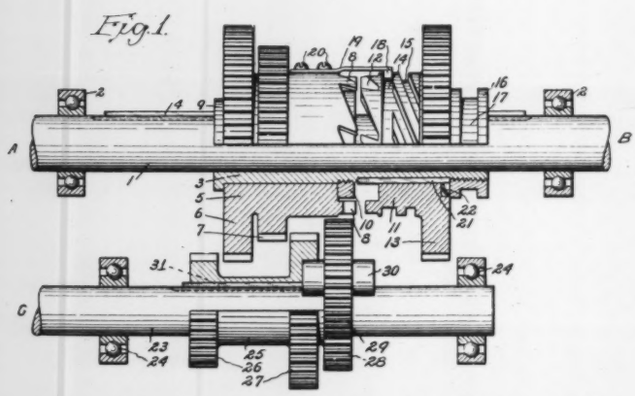
NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining To Design

DEVISED to establish continuous operation of a shaft by providing connection with another shaft whereby a reserve would mesh in to carry the load if the usual source of power failed, an automatic clutch mechanism recently was granted patent No. 1,752,937. The inventor is David A. Barnett, and Heany Laboratories Inc., New Haven, Conn., is the assignee.

Among the applications for an arrangement of this type is that of starting a prime mover by means of another unit to afford means of disengagement when the prime mover picks up speed. Another application in connection with prime movers incorporates a slipping clutch arranged to drive only above a predetermined speed. In addition there is an auxiliary shaft driven by the same prime mover with a reduction gear between the two shafts, so that the load is started at slow speed. At some predetermined speed ratio, the direct drive overcomes the reduction gear drive and releases it from driving connection.

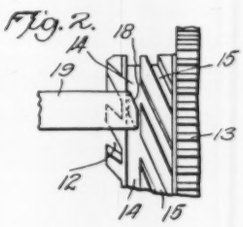
Conversely, if the slipping clutch used for direct driving is affected by increased torque and causes



Automatic clutch mechanism in which a tooth 18 *and a spiral groove* 15 *respond to speed and torque conditions*

the shaft speed to drop to the predetermined ratio with the second shaft speed, the device automatically meshes the second shaft into driving connection with the first through speed reduction. A side view of the automatic clutch mechanism is shown in Fig. 1. When shaft 1 is not in motion and gears 6—26 or 7—27 are in mesh, the application of power to shaft 23 at C will cause the member 5 on sleeve 3 to rotate. Member 11 on sleeve 3 tends to move toward 5 because of the spring 22 so that as tooth 18 is carried around by the revolution of 5 it will engage in the spiral groove 15 and draw 11 toward 5 until jaw clutch 8-12 is engaged.

When this is accomplished shaft 1 is driven



Plan view of the tooth and spiral groove, showing details of construction and principle of operation

through key 21, sleeve 3 and key 4 by the power transmitted from shaft 23 at a speed determined by the intermediate gear ratio. If direct power then is applied to shaft 1 at A as by the engagement of a slipping clutch, sufficient to propel the shaft at a higher speed than it is being driven, 11 will gain speed and the jaw clutch will force members 5 and 11 out of engagement and the member 5 will continue to run free, while 11 continues to run at the speed of shaft 1 and is held out of engagement with the member 5 by means of the tooth 18.

When direct power driving shaft 1 is decreased, as by increased torque requirements at B the slipping is increased to a point when the speed of shaft 1 and sliding member 11 becomes equal to that at which revolving member 5 is driven by the gear reduction from shaft 23. As this occurs the same conditions prevail as when shaft 1 was at a standstill and the same operation of meshing between members 5 and 11 takes place and shaft 23 drives shaft 1 as long as the speed conditions and torque continue.

AN antifriction bearing which automatically returns to normal center position when free from load has been invented by William A.

Geiger, Chicago. Granted patent No. 1,750,797 recently, this new device was assigned to W. H. Miner Inc., Chicago. It is particularly adapted for railway car side bearings and provides a boxlike retainer with antifriction elements and vertically arranged helical springs.

A covering cap is utilized which bears upon the antifriction elements, the bearing surfaces of the cap and of the retainer being arranged on parallel arcs whereby movement of the bearing from either side of central position does not cause elevation of the cap. Curved bearing surfaces of the retainer aid in returning the antifriction elements and cap to central positions.

The vertical sectional view shown in Fig. 1 of the accompanying illustration at the bottom of this page, is taken through the ends of the body and truck bolsters of a railway car. Fig. 2 is a transverse sectional view corresponding to the line 2—2 in Fig. 1. Antifriction elements B—B rest upon curved bearing surfaces 24—24. Rollers B—B are similar in construction and are provided with cylindrical sockets or recesses 28—28 in opposite ends. The upper periphery of each roller B has teeth or ribs 29 adapted to co-operate with the cap E.

Each bearing surface 31 is provided with a plurality of transversely disposed ribs or teeth 34 adapted to mesh with teeth 29 on the rollers B—B. The cap is fastened to the housing A by means of laterally extending ledges 35—35 extending along its side faces, the housing A being equipped with bendable lugs 36—36.

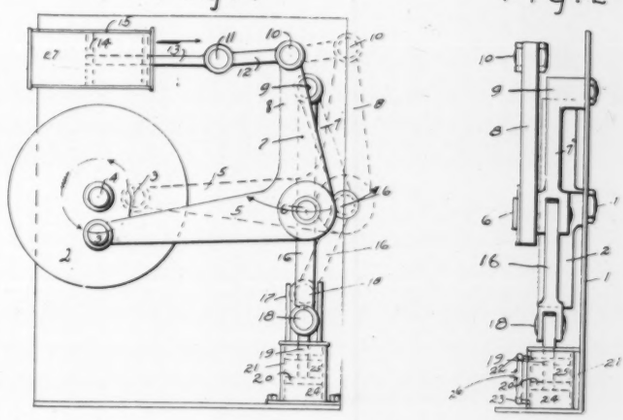
Transmitting means C—C, of which there are two, are made up of elongated links provided with inturned cylindrical portions 38—38 at opposite ends. Resilient means D—D, of which there are two also, are comprised of helical springs, extending through the opening 40 in the projection 39 of the transmitting member. The lower ends of the springs are secured to lugs 42.

In operation when the bearing is under load the covering cap will move to either side, causing movement of rollers B—B. During this movement the transmitting members are carried with the rollers, flexing the springs until the load is removed, at which time contraction of the springs returns the rollers to central position. Since the teeth 29 engage with teeth 34 the cap also will be returned to central position.

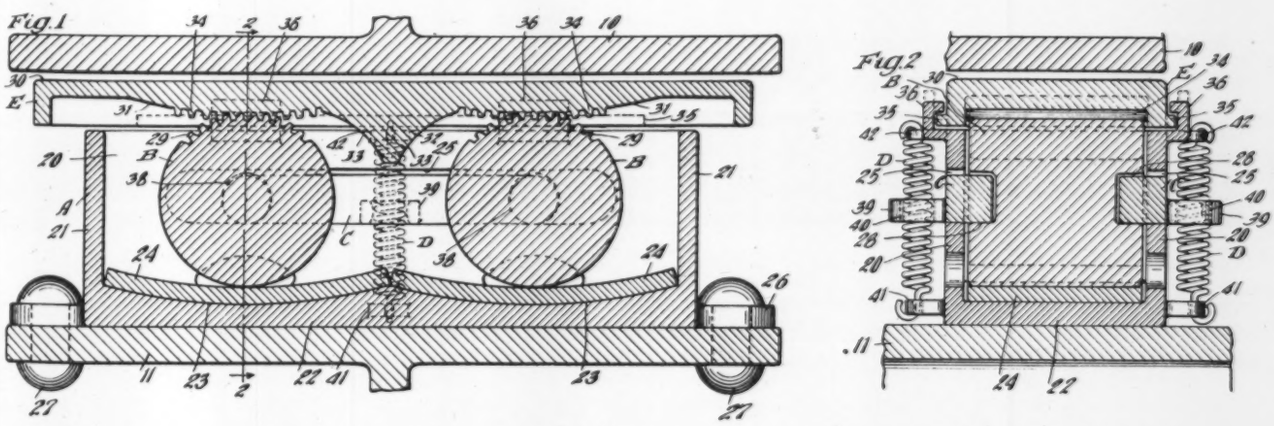
TO OVERCOME dead centers, John H. Towers has designed an improved mechanical movement to be employed for converting reciprocating movement into movement of rotation. For his invention he recently was granted patent No. 1,753,485. This device is applicable for use in connection with steam engines, gas engines, windmills and hand operated apparatus or in any relation it is desired to eliminate dead centers.

In the accompanying illustration, Fig. 1 is a side view of the device shown connected at one end to a reciprocating piston and at the other end to a wheel. Fig. 2 is an end view of the same. Assuming that compressed fluid enters into pres-

Fig. 1 Fig. 2



Side view (Fig. 1) of dead center device, showing pistons and wheel. Fig. 2 is an end view



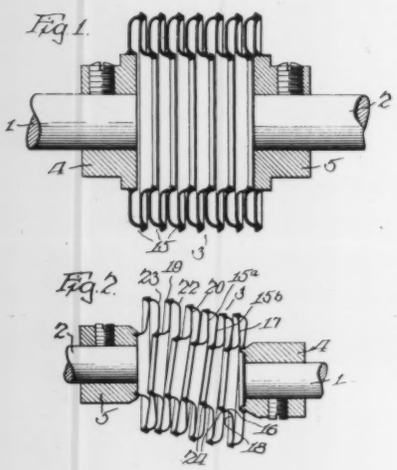
Sectional view of antifriction bearing embodying helical springs and rollers is shown in Fig. 1. Construction details of bearing cap and retainer are given in Fig. 2

sure cylinder 21 in the chamber 25 and remains a constant pressure as long as the wheel is to rotate in that direction; compressed fluid is allowed to enter into cylinder 15 in the chamber 27, whereupon the piston 14 is moved to the right in the direction of the arrow.

As the angle crank reaches the position indicated by the full lines or what would be dead center position, the pressure still acting on piston 14 throws the pivot 3 past the dead center. At this moment downward pressure on piston 20 gives the wheel 2 continuous motion, the same thing occurring at the opposite dead center, and the wheel continues to rotate in a counter clockwise direction.

Among changes which might be incorporated without departing from the principle of the invention, the angle crank could be a T crank and the power applied below pivot 6, the result being a reverse motion. In place of the compression cylinder any means may be employed which will produce a pressure upon the oscillating pivot on rocker arm 7.

FEATURES of a recently patented flexible coupling include construction in which there are no moving surfaces in contact to cause friction and wear. The patent was granted to Lawrence M. Persons, under No. 1,752,106. Cook Electric Co., Chicago, is the assignee. Use of this coupling, it is claimed, not only permits the shafts to be out of line but it will submit to a certain amount of relative longitudinal movement between the connected parts of the driving and driven shafts.



Flexible metallic plates are fastened together to form the flexible coupling shown in Fig. 1. When subjected to angular movement of the shafts the coupling responds as shown in Fig. 2

The invention is particularly concerned with the provision of a practical form of flexible coupling or universal joint, wherein the parts are united in a manner preventing destruction or weakening of the material at the unions.

A longitudinal sectional view of the coupling is shown in Fig. 1, while Fig. 2 is an elevational view illustrating the manner in which the device permits angular movement between drive shaft and driven shaft. Fig. 3 is an enlarged detail view of several members forming the coupling

Members forming the coupling are connected together as shown. Solder is used to secure flanges in the gutters

to illustrate the manner in which they are connected together.

The coupling comprises a plurality of flexible metallic plates 15 formed to allow circumferential edge engagements between the plates, the inner and outer peripheries of these plates affording a peripheral union with the edges of opposite adjacent plates to provide a continuous expandable and collapsible wall.

Assembling of the plates is shown in Fig. 3. Gutter 21 is adapted to receive a flange on the next succeeding plate and solder is allowed to flow freely about the gutters to insure a solid joint. Flange 22 also is joined to plate 15*b* by a curved portion 23. Gutter 21 is joined to plate 15 by curved portion 24. The formation of plates 15*a* and 15*b* causes the deflection to be confined to the flat portions 17 and 25 of these plates, this being accomplished by the curved portions 18, 20, 23 and 24, which prevent any bending strains from being transmitted to the flange and gutter connections.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

VALVE TAPPET—1,748,703. A mechanism comprising an engine having a fluid pressure system and a plurality of tappets and means for turning these tappets through the force of the pressure in the system. Assigned to Chrysler Corp., Detroit, Mich.

POWER TRANSMISSION—1,751,576. Covered by this patent is the "combination of a car axle, a gear thereon having teeth of sufficient length relative to the pitch diameter to form between adjacent teeth relatively large pockets extending in a radial direction, a gear adapted to be driven from said car axle gear, and a generator mounted in fixed relation relative to said car axle." In addition the invention includes "means for mounting said second gear to permit it to move toward or away from said car axle gear upon foreign matter lodging therebetween and means connecting said second-mentioned gear

to the generator to drive the latter and adapted to maintain driving connection throughout the relative movement between said two gears." Assigned to The Safety Car Heating and Lighting Co., New York.

MECHANICAL MOVEMENT—1,751,646. Embodied in this invention is a plurality of force applying elements arranged to move relatively to each other in different directions under the influence of impressed forces. Means are employed for holding the elements against relative movement except under predetermined conditions. When such movement is permitted, means including a movable member which all elements engage, is provided along with a guide for said member which effects a reactive force thereon to hold the same stationary when one of said elements is active. The elements are effected only when at least two of said elements act concurrently to jointly produce a force which unbalances any existing reactive force, whereupon the movable member will move to permit relative movement of all of the active force applying elements. Assigned to Henry W. Nieman.

CHROMIUM PLATED WORM SHAFT—1,753,773. Covered by this patent is "the combination with two parts having frictional engagement with each other, one of said parts having an ingredient tending to alloy with the other, but not with chromium, under the influence of friction, of a coating of chromium on one of said parts." Assigned to A C Spark Plug Co., Flint, Mich.

LUBRICATING SYSTEM—1,753,560. A central lubricating recently patented, comprises in part a lubricant supply, a plurality of parts for receiving lubricant, a suction pump device, a piston operating in the chamber of the pump, and a push button control for admitting or cutting off both suction and lubricant. Assigned to Alemite Corp., Chicago.

BOX CAP BEARING—1,754,195. A patent recently was granted for a loom crank shaft box cap bearing comprising a bracket secured to the loom frame and having a lower bearing for the crank shaft, a box cap and projecting lugs on the bearing and cap, bolts to secure the cap at one side of the bearing, and elongated stud bolt to engage lugs for fastening cap at other side of bearing. Assigned to Draper Corp., Hopedale, Mass.

BEARING MATERIAL—1,751,780. A bearing has been patented for devices "adapted to be transversed by electrical currents without pitting; comprising a sleeve member adapted to fit over a journal member through which an electric current may pass; said sleeve member having a body of metallic tungsten impregnated with a relatively light, low melting-point metal and a relatively small amount of a hardening agent whereby to impart hardness and self-lubricating characteristic to the sleeve member, the tungsten being taken in an amount not greater than eight parts by weight for a whole of ten parts." Assigned to P. R. Mallory & Co., Indianapolis, Ind.

FREE-WHEEL DRIVE—1,751,868. "A final drive for vehicles comprising driving wheels, a differential, a power shaft journaled in the differential housing and carrying driving planetary pinions, a stub shaft mounted in the housing, spaced bevel gears on opposite sides of the pinions journaled on the respective shafts, spaced skew bevel gears driven by the respective bevel gears and journaled on the respective shafts, shafts driving the respective wheels and mounted above the axis of the differential, and skew bevel pinions on the last named shafts engaging the respective skew bevel gears." Assigned to International Motor Co., New York.

Hydraulics in Design

(*Concluded from Page* 39)

ing at speeds established by the rate of oil flow, and that the drive remains properly timed only because the load variations do not cause an appreciable departure from the set speeds. This should not be interpreted to mean that a hydraulic drive of this type is absolutely positive. There is, as stated in the first section, a small internal leakage; it is this leakage only which is affected by changes in load. In designing applications where timing is important small time margins should be allowed to cover minor departures from the exact set speeds. The slight elastic yielding due to compression of the oil also should be taken into account. Amount of this yield is roughly ½ per cent per cent of the volume under pressure per 1000 pounds per square inch change in pressure for light lubricating oil. This figure includes a small allowance for stretch of piping, etc., in addition to the volume change of the oil itself.

The list of characteristics commencing on page 35 gives to the best of my knowledge, the reasons which have led to the adoption of hydraulic motions on machinery during the last few years. Of the nine basic systems of hydraulic power transmission tabulated on page 28 of the March issue, volumetric units are used in the fourth, fifth and sixth systems. They also can be used to advantage in the first, seventh and eighth systems in some cases. It is the "New Hydraulics," which, more than the old, offers solutions to most of the foregoing problems, and it is because this type of equipment now is available and accredited that increasing numbers of designers are solving problems of machine design hydraulically.

Examples and applications of the other fundamental characteristics of the hydraulic method will appear in the next section of this series in a later number.

Diesel Uses Large Coupling

A SPRING coupling believed to be the largest ever built, the outside diameter being 59 inches and the weight 4½ tons, recently was installed on a diesel engine drive of a suction pump used on the Standard Dredging Company's dredge "New York." Springs of the helical type are placed in two rows, one in the driving half and one in the driven half. A floating rim is used to transmit the load from one row of springs to the other.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

APPOINTMENT of Dr. Karl Taylor Compton as president of the Massachusetts Institute of Technology has been announced. He now is head of the physics department of Princeton university and will assume his new office in July, when Dr. Samuel W. Stratton leaves the president's chair to become chairman of the executive committee and of the corporation of the institute. At the age of 42, having been born in Wooster, O., in 1887, Dr. Compton is a physicist of wide repute. Besides holding several high degrees he is a member of a number of honorary and technical societies. During the world war he was aeronautical engineer in the signal corps and later associate scientific attache to the American Embassy in Paris.

INAUGURATION of Loughnan St. L. Pendred, as president of the Institution of Mechanical Engineers in England was consummated recently. Mr. Pendred is prominent in British engineering circles and editor of *The Engineer*. After attending Finsbury Technical school, he served his apprenticeship with Davey, Paxman & Co. Ltd., Colchester, England. Completing this training he became associated with Ven den Kerchove of Ghent, Belgium, in development engineering and later with Chemin de Fer de l'Ouest of Paris and Rouen, France, then with Whitworth & Co., Elswick, England, in a similar capacity. Joining the staff of *The Engineer* in 1896, Mr. Pendred worked as assistant editor until 1905 when he was appointed editor. He headed the British engineers in the World Engineering congress and was a fiftieth anniversary medalist at the American Society of Mechanical Engineers celebration.

DISTINGUISHED achievement in management, in which he was early to recognize the importance of scientific principles, won Fred J. Miller the Gantt medal award at the anniversary celebration of the American Society of Mechanical Engineers. It was he who made possible one of the first applications of these principles on a large scale. Major Miller, industrial engineer, was editor-in-chief of the *American Machinist* for ten years and for eight years he was general manager of the factories of the Union Typewriter Co. During the World war he served as major in the ordnance department of the army. He is a fellow of the American Association for the Advancement of Science and has been a member of the American Society of Mechanical Engineers since 1890, serving as president in 1920.

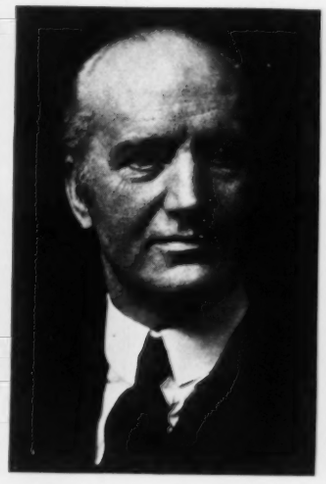
NUMBERED among the American Society of Mechanical Engineers fiftieth anniversary medalists was Conrad Matschoss of Germany. This honor was bestowed during the recent anniversary celebration in recognition of his outstanding record as a director of the Verein deutscher Ingenieure, the Society of German Engineers, and as a promoter of engineering interests and technical education. Born in 1871 at Neutomischel (Posen), Dr. Matschoss studied engineering in the Technical University of Hanover. From 1898 to 1906 he taught mechanical engineering at Cologne. He wrote his first book in 1901 on the history of the steam engine. In 1906 he joined the editorial staff of V. D. I.

RANKING with the engineering leaders of today, Prof. Daniel Dresden, from the Netherlands, also was a recipient of the American Society of Mechanical Engineers fifteenth anniversary medal. Amsterdam was his birthplace and he obtained his early technical training there. Later he attended the Technical Academy at Delft, receiving a degree in mechanical engineering in 1910. Engaging in design he held positions with the Lips Works and also with Stork Bros., of Hengelo, Netherlands, as chief designing engineer in the steam turbine and centrifugal pump departments. In 1920 Prof. Dresden was appointed professor of mechanical technology at the Technical Academy of Delft, and he orginated and edited "de Gietery," a monthly foundry journal. Since 1928 he has been president of the Jaffa Iron Works, Utrecht, Netherlands.

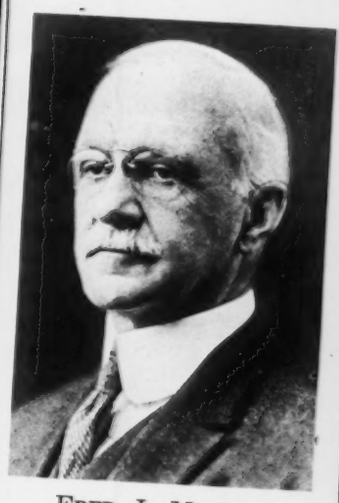
WHEN Dr. Samuel Wesley Stratton retires from the president's chair of Massachusetts Institute of Technology in July he will have com-

Leaders in Design, Engineering and Research

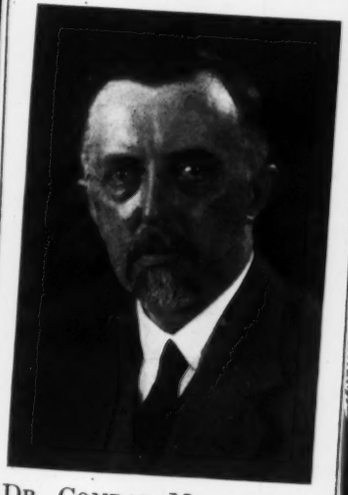
DR. KARL T. COMPTON



L. ST. L. PENDRED



FRED J. MILLER



DR. CONRAD MATSCHOSS

PROF. DANIEL DRESDEN

© Harris & Ewing

DR. S. W. STRATTON

pleted eight years in that capacity. He becomes chairman of the executive committee and of the corporation, sharing with Dr. Karl Taylor Compton, who will then take office as president, the responsibilities of administration. Born on a farm in Illinois in 1851, Dr. Stratton showed an early interest in mechanical engineering and after finishing school entered the University of Illinois. Two years after receiving his B. Sc. degree in mechanical engineering in 1884 he joined his alma mater as instructor, later becoming professor of physics and electrical engineering. It was largely through his efforts that congress passed a bill March 3, 1901, establishing a national bureau of standards of which he served as director until 1923. He holds a number of honorary degrees and is affiliated with many scientific organizations.

* * *

Louis Coatalen, managing director, and Frank Martinuzzi, head of the experimental engineering office, of the Sunbeam Motor Car Co., Wolverhampton, England, were guests of the Metropolitan section of the Society of Automotive Engineers at a dinner given April 2 at the A. W. A. clubhouse in New York. Mr. Coatalen, designer of the Silver Bullet in which Kaye Don competed for the world's land speed record recently, described its features in an address following the dinner.

* * *

D. H. Webber has been appointed chief engineer of American Eagle Aircraft Corp., Kansas City, Mo., succeeding H. J. Stoneburner, resigned. Mr. Webber formerly was assistant chief engineer for Wallace Aircraft Co., division of American Eagle.

* * *

Otto A. Banner, recently appointed consultant for the Busch-Sulzer Bros. Diesel Engine Co., noted in a recent issue of MACHINE DESIGN, has also been appointed chief engineer and manager of the coupling department of the John Waldron Corp.

* * *

W. M. Scarth has been appointed assistant research engineer with the Auburn Automobile Co., Auburn, Ind. He formerly was assistant specifications engineer of the General Motors Co., Oshawa, Canada.

* * *

Robert Hoierman, of Alliance, O., formerly field executive of the Memorial Craftsmen of Ohio, was appointed executive secretary of the Ohio Foundries Association Inc., at a recent board meeting. Mr. Hoierman was born in Bloomington, Ill., in 1890 and was graduated from the University of Illinois in 1912 as bachelor of science in mechanical engineering. He succeeds Elmer F. Scott, resigned.

* * *

Kenneth M. Ronan has been elected president of the Warrior Aeronautical Corp., Warren, O., successor to Alliance Aircraft Corp. Mr. Ronan formerly was chief engineer of the Stinson Aircraft Corp., Detroit.

* * *

W. T. Brickenden, formerly chief engineer of the Riley Engineering & Supply Co. Ltd., recently joined the organization of Thorne, Mulholland, Howson and McPherson, Toronto, Ont., as mechanical engineer to take charge of the engineering department.

* * *

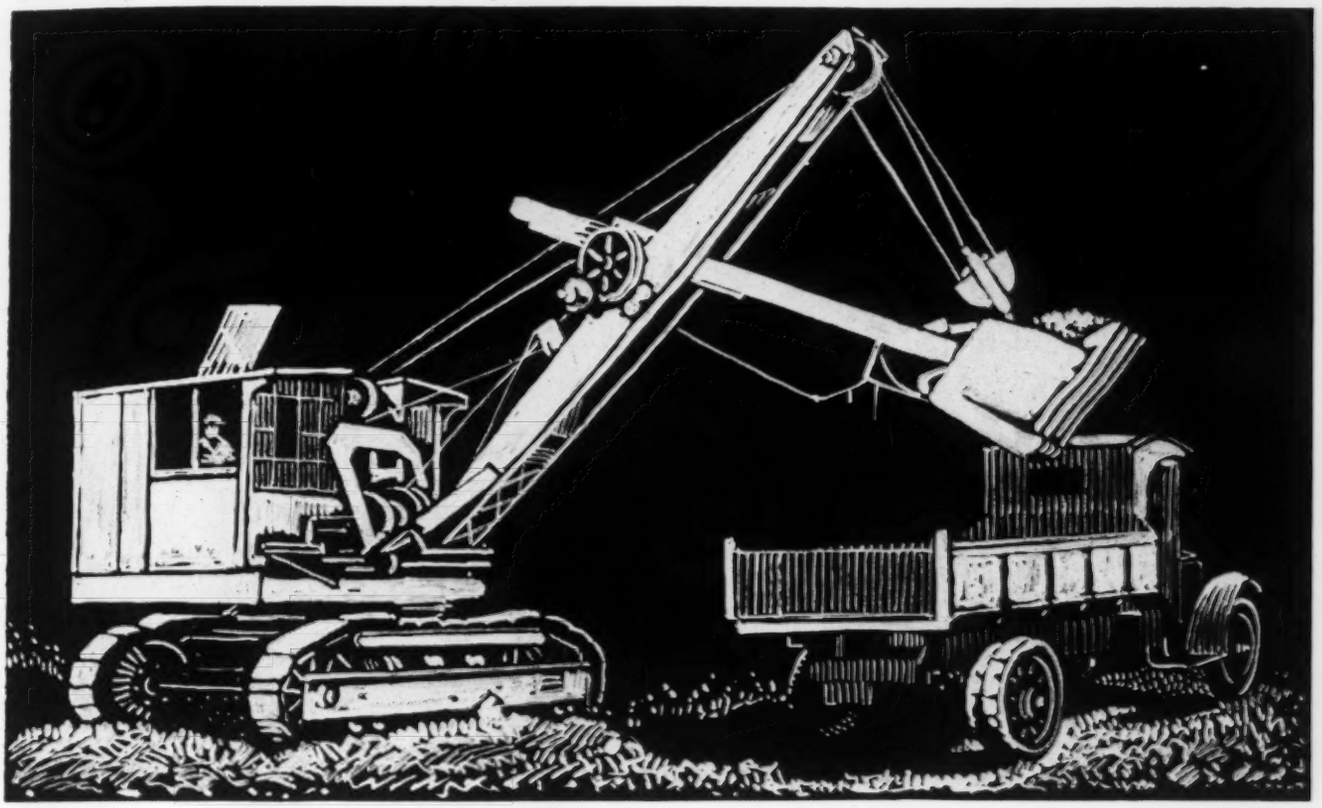
Clyde E. Williams, formerly chief metallurgist for Columbia Steel Corp., San Francisco, has been appointed assistant director of Battelle Memorial institute, Columbus, O., a foundation devoted to research in metallurgy and fuels and which provides facilities for co-operative research projects in industry. He has been a member of the institute's staff since September, 1929.

* * *

Prof. A. H. Blaisdell, mentioned in the April issue of MACHINE DESIGN as having been made chief technical advisor of Franklin Aircraft Corp., Franklin, Pa., is associate professor of mechanical engineering, in charge of instruction of aeronautics at Carnegie Institute of Technology, Pittsburgh. Prof. Willibald Trinks is head of the department of engineering at that institution.

* * *

Homer S. Trecartin has resigned, effective April 1, as general manager of Roller Bearing Co. of America, Trenton, N. J., to become affiliated with the Russian organization, Sharikopdskipnekstroy, represented in this country by the Amtorg Trading Corp., New York. Mr. Trecartin will direct the design and equipment of a new ball and roller bearing plant to be built by this organization in Moscow, Russia, and which, it is said, will be one of the largest plants in the world producing this type equipment. Mr. Trecartin is to have charge of development of production after the plant is in operation.



Builders of Roads Are Builders of Empires

THROUGH the centuries the progress of civilization has gone hand in hand with the development of national highway systems.

Ancient Rome reached the apex of its power and splendor on hard surfaced roadways that still defy the attack of time. Where once the chariots of the conquerors rumbled slowly on with prisoners of war shackled to the axles, modern motor cars today in swift flight pass.

No greater is the contrast between the chariots of the Caesars and today's motor cars, than the contrast between Roman road-building methods and those we now know.

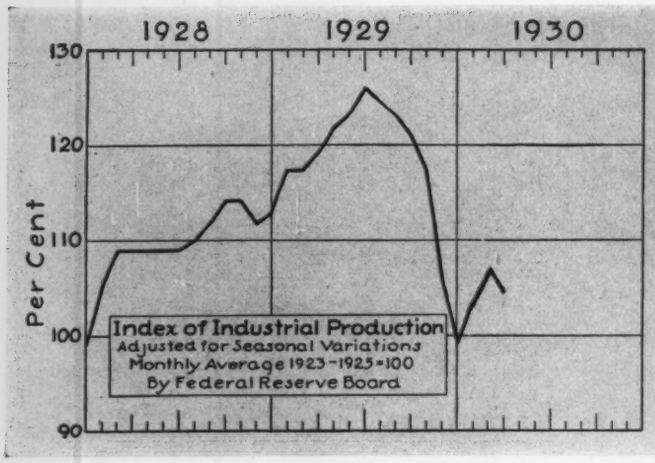
For instead of generations of back-breaking toil by countless human beings to build one highway, modern road making machinery with marvelous efficiency lays mile after mile of vehicle bearing hard surface with steady regularity.

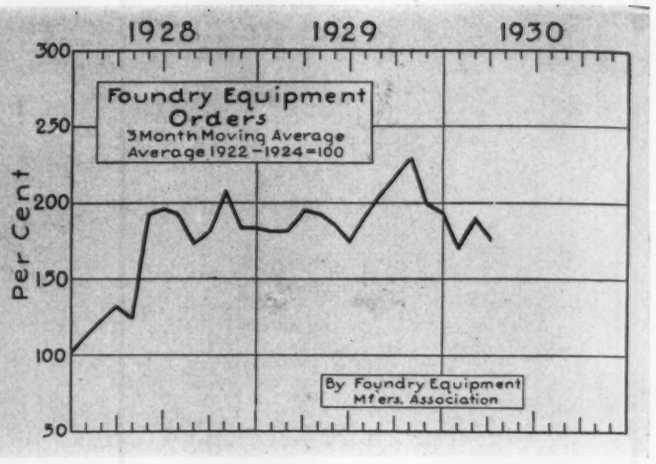
The engineers who have created and designed these wonderful machines have done their work well. To them these new Empires owe much, for without them modern civilization would not exist.

In trucks and tractors, in shovels, cranes, concrete mixers and similar road-building equipment where utmost strength and dependability are demanded in all moving parts, just as in hundreds of other industrial machines built for hardest service, these designing engineers have found that *no other material takes the place of Columbia Cold Finished Steel Products.* . . . . . .

Columbia Steel and Shafting Co., Pittsburgh, Pa.

COLUMBIA
COLD FINISHED BARS AND SHAFTING



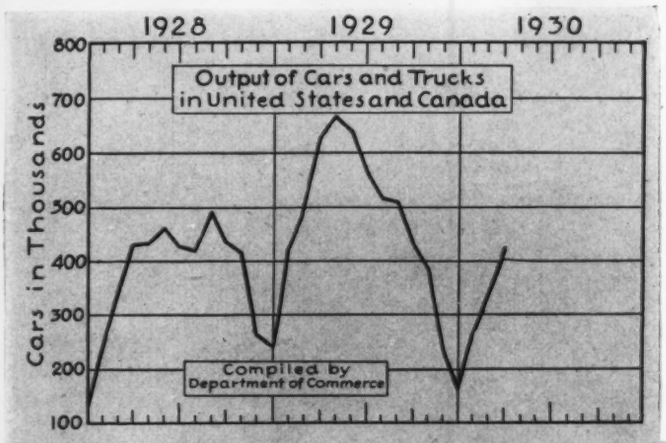


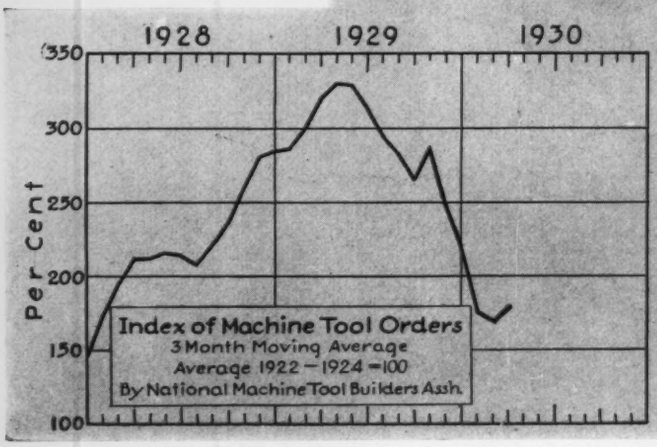
How Is Business?

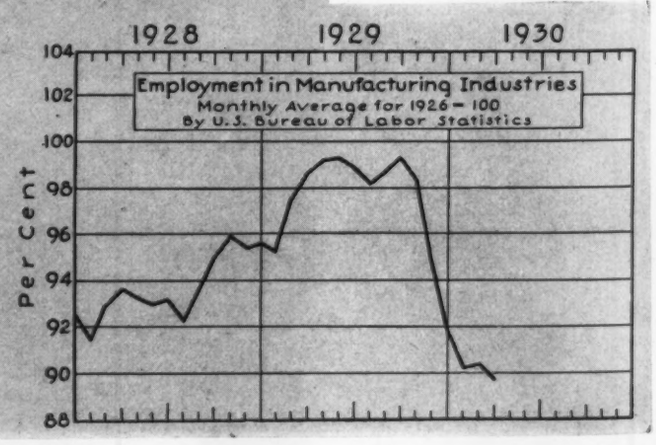
PREVAILING conditions in business continue irregular. For industry as a whole a mediocre summer is ahead. The industrial production index prepared by the federal reserve board again shows a decline. Recession in commodity prices augmented by little improvement in employment conditions cloud the situation.

There is, moreover, another scene which reveals torpidity in steelmaking operations and spotty automotive activity. With caution as the guiding influence industry is believed to be building a firm foundation for a future upturn. This caution is particularly shown in the machinery market. Inquiries with the exception of those in the Chicago district are quiet. Grinding equipment, presses, special drills and other machines amounting to $1,250,000 made up a list recently closed by a Chicago company. In the New England district bearing manufacturers are fairly active. Demand for grinding machinery has declined. Export trade is moving, Amtorg Trading Corp. being nearly ready to close on another large list of machinery for Russia.

A large manufacturer of electrical apparatus has announced price reductions of 3 to 5 per cent covering various standard lines of this type of equipment. Reflection of the recent recession in copper prices from 18.00c to 12.50c is seen in the reduction of this company's products. Cold drawn or rolled bars, and shafting hold at 2.10c; and 20.50 is asked for yellow brass. Spring wire is 3.40c and machine bolts, all sizes, are quoted 60 to 70 off.



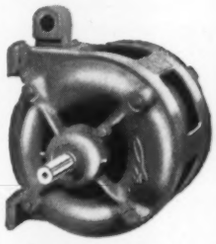




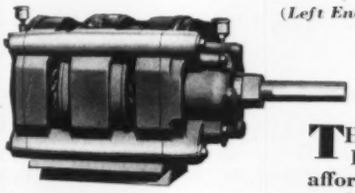
A Study in Modern *Motorization*

with LOUIS ALLIS *motors*

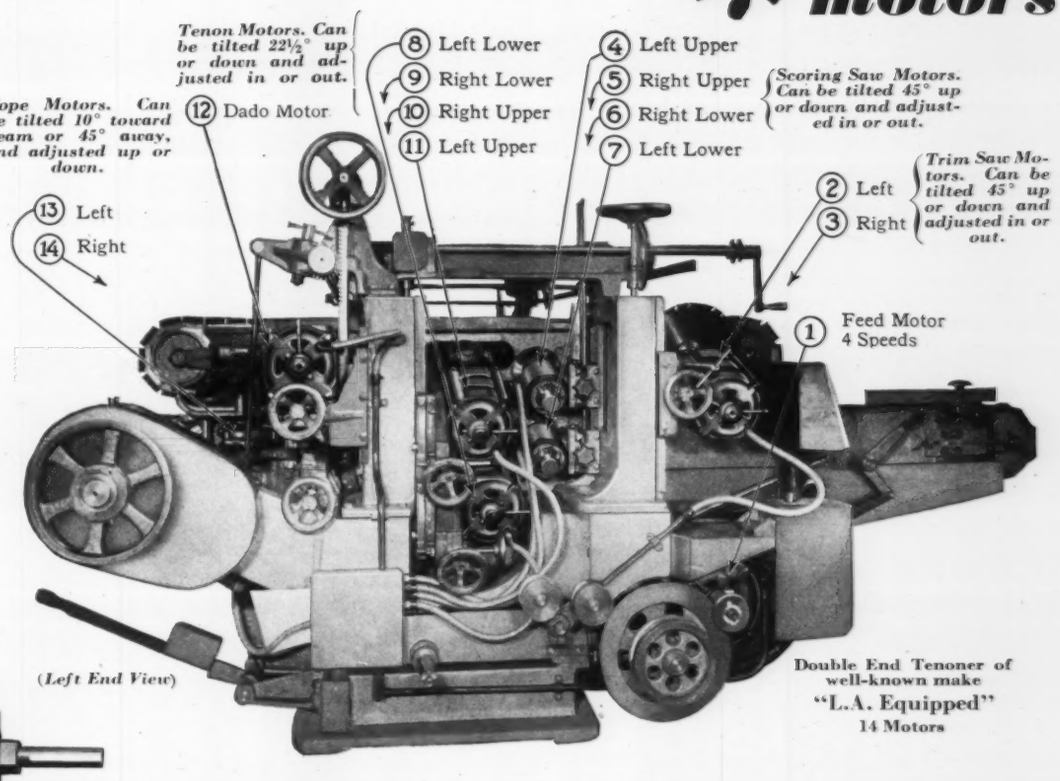
"Built-in" shaftless rolled shell type motor, as furnished for scoring saws.



4-Speed ball bearing motor as used on feed.



Arbor Motor with extra heavy ball bearings and shaft for mounting trim saw or tenon head. Small overall diameter permits using heads of small diameter. Dovetail foot for sliding adjustments. Cope and Dado motors same except for shaft.


Tenon Motors. Can be tilted 22½° up or down and adjusted in or out.
8 Left Lower
9 Right Lower
10 Right Upper
11 Left Upper
12 Dado Motor
Cope Motors. Can be tilted 10° toward beam or 45° away, and adjusted up or down.
13 Left
14 Right
4 Left Upper
5 Right Upper
6 Right Lower
7 Left Lower
Scoring Saw Motors. Can be tilted 45° up or down and adjusted in or out.
2 Left
3 Right
Trim Saw Motors. Can be tilted 45° up or down and adjusted in or out.
1 Feed Motor 4 Speeds

(*Left End View*)

Double End Tenoner of well-known make
"L.A. Equipped"
14 Motors

THIS Double End Tenoner—with its 14 Louis Allis "Custom-Built" motors—affords an excellent study in modern motor application. It demonstrates how motors—when "built for the job"—create better performance and greater machine efficiency.

Motors of smallest diameter . . . specially built for operation in any position . . . heavy shafts for mounting cutter heads . . . dovetail feet for sliding adjustments . . . perfect balance at high speed . . . individual control . . . high efficiency and power factor . . . these features of its L.A. "Custom-Built" motors have helped create the *accuracy*, *flexibility*, and *economy* for which this machine is famous in the woodworking industry.

And this example is typical. From both an engineering and sales standpoint, builders of machine tools, woodworking, laundry, ventilating, pumping, conveying, and other modern production machines are finding that it pays to use L.A. "Custom-Built" motors. Louis Allis engineers will gladly cooperate with you in selecting or designing motors exactly suited to your needs.

Write for Bulletins on Louis Allis "Custom-Built" Motors

LOUIS ALLIS

"CUSTOM-BUILT"
Electric MOTORS

THE LOUIS ALLIS COMPANY
MILWAUKEE, WIS.

Motor Specialists for 28 Years — Offices in Principal Cities

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

STANDARDIZATION and gear nomenclature were subjects of interesting discussion at the fourteenth annual meeting of the American Gear Manufacturers' association at Hotel Gibson, Cincinnati, May 1-3. A paper on "Gear Nomenclature Symbols," by A. H. Candee, Gleason Works, Rochester, N. Y., incited lengthy comment. He advocated single letter symbols with subscripts. Emil Dukes, chief engineer, Gears & Forgings, Cleveland, presented a paper on "Load and Speed Conditions of Worm Gears Drives." An address, "The Outlook for New Developments in the Machine Tool Industry," was given by E. F. DuBrul, manager, Machine Tool Builders association.

The report of the committee on transmission roller chains, sprockets and cutters was adopted as American Gear Manufacturers' association practice. This is a proposed American standard and is subject to the approval of the American Standards association.

New Officers elected were: President, B. F. Waterman, Brown & Sharpe, Providence, R. I.; first vice president, E. W. Miller, Fellows Gear Shaper Co., Springfield, Vt., and second vice president, John Christensen, Cincinnati Gear Co., Cincinnati.

* * *

All-American Aircraft Show Held at Detroit

Two outstanding features in aircraft development at the All-American aircraft show at Detroit April 5 to 12 were the 32-passenger Fokker and the Packard aircraft diesel engine. Both commanded unprecedented interest and were singular examples of what is being accomplished in design in this field. The initial showing of the Packard diesel described in the April issue of MACHINE DESIGN was subsequent to an announcement that this type of engine would be optional as power plant installation on the Ford tri-motor airplane. Three sessions devoted to technical papers were sponsored by the aeronautic division, Detroit section of the Society of Automotive Engineers.

Detroit's new $1,000,000 hangar and exhibition was the scene of the exposition. A total of 82 machines and four gliders were on display within the building, while approximately 50 additional planes were stationed outside. On the opening day over 14,000 persons attended. Metal as a material for the fuselage exemplified the tendency toward the use of this type of construction. With drastic cuts in the prices of some of the well-known models, airplane parts manufacturers expect to feel a jolt. However, they anticipate more substantial orders to do away with hand-to-mouth buying, a characteristic typical of the industry recently.

* * *

Road Machinery Exhibit Is Planned

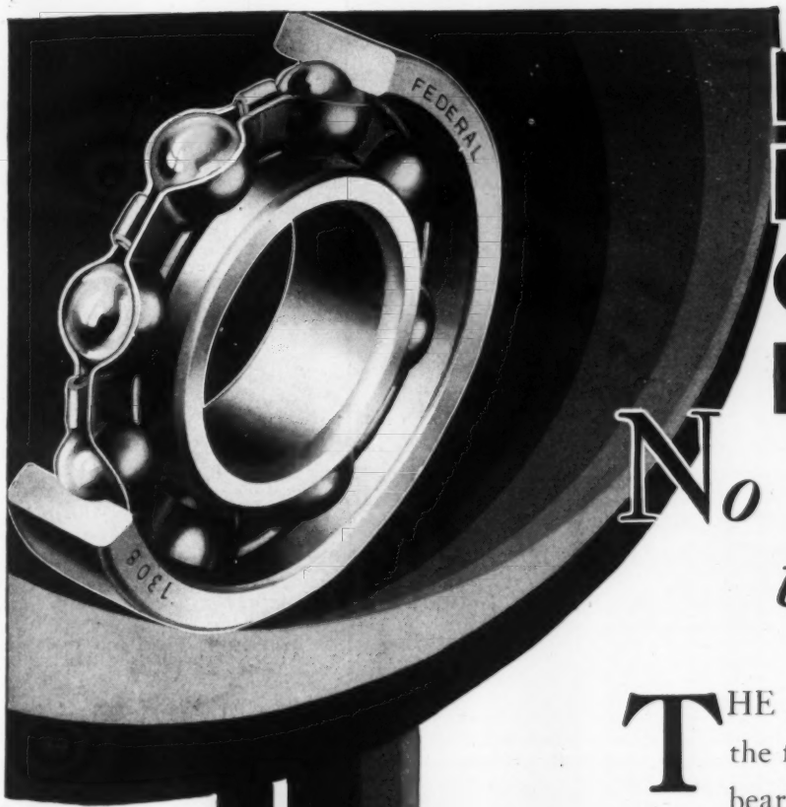
In conjunction with the sixth international road congress to be held at Washington auditorium, Washington, Oct. 7-10, by the American Road Builders' association, an exhibition will be held to show the products of the American highway manufacturers. This exhibit will be international in scope and is expected to attract delegates from 56 countries. Progressive ideas and methods of American engineers will be studied by these foreign delegates. Since the United States produces for domestic use and export more road building machinery and equipment than any other nation, an exhibit of this nature will afford an unusual and interesting opportunity for study of design trends. Besides 400 American manufacturers' exhibits road machinery builders from other countries are being urged to send their products to the show.

* * *

Fiftieth Anniversary of A. S. M. E. Observed

Progress in mechanical engineering over a period of fifty years was observed recently by the American Society of Mechanical Engineers, commemorating the founding of the organization in 1880. Ceremonies began April 5 in New York and closed in Washington April 9. The unveiling of the anniversary tablet in the lobby of the Engineering Societies building was one of the impressive events.

A colorful pageant depicting the power which constant engineering development has endowed



BETTER BEARINGS CANNOT BE HAD...

No matter what the price..

THE steel that goes into these bearings is the finest high carbon chrome steel. Each bearing is made with utmost care and precision. Every operation is checked. Every bearing part tested and calibrated. The most minute inspection follows every step in processing. The result is—a bearing of unusual quality giving better service and capable of sustaining the name and reputation of FEDERAL RADIAL BALL BEARINGS.

The Mark of a Good Bearing

These are the reasons why we feel justified in making the statement that better bearings cannot be obtained, regardless of price!

THE FEDERAL BEARINGS COMPANY, INC.
Poughkeepsie, N. Y.

Associated with
The Schatz Manufacturing Co.,
Manufacturers of Commercial Annular Ball Bearings

Detroit Sales Office: 917 Book Bldg.

FEDERAL

civilization was presented at Stevens institute. After a welcoming dinner and festivities in New York the celebration was continued in Washington. Greetings were received from 21 countries, and other societies, engineering colleges and organizations throughout the United States extended congratulations.

Scientific monographs were presented in summarized addresses from 16 countries. The monographs were prepared specially for this occasion and covered the humanistic aspects of engineering in the various countries. Eminent engineering authorities prepared them and appointed representatives made the presentations. The six surviving founders of the society received medals in honor of their achievement. These were presented at a founder's luncheon in the ballroom of Mayflower hotel. John R. Freeman, past president of the society presided and presented the medals. Ambrose Swasey, Cleveland, made the response in behalf of the founders.

* * *

Aeronautic Safety Theme of World Congress

Plans are being completed for the first international congress for aeronautic safety which is to be held in December under the auspices of the French government, notably Laurent Eynac and Marshall Lyautey. The program will consist of meetings dealing with problems of aeronautic safety and practical demonstrations by manufacturers and inventors, both foreign and French. A visit to the Aeronautic Salon of Paris, which will be in session at the same time, and inspection trips to the various French aircraft factories, airports and commercial aircraft establishments will be among the featured events. A bulletin giving details of the congress may be obtained from Henri Brunat, 23, Avenue de Messine, Paris, 8, France.

* * *

Foundry Show Reveals Progress in Design

Amazing developments in equipment, which promote the mechanization of operations in the foundry and simultaneously provide closer control of variables entering into foundry practice, were outstanding at the foundry show at public auditorium, Cleveland, during the week of May 12. This exposition was held in connection with the thirty-fourth annual convention of the American Foundrymen's association.

Machines of various types were exhibited and in many cases represented the work of leading engineers during the past two years. The last major exhibit was held in Philadelphia in 1928 and since that time remarkable changes have taken place in design trends. Technical papers brought out many new features in foundry practice and developed a wealth of information.

* * *

Scientific Advisory Board Created

A scientific advisory board made up of five leading engineers from the universities of the East and Middle West, has been created to confer with Westinghouse research engineers on scientific developments. It is composed of Dr. G. B. Waterhouse, head of the department of metallurgy at the Massachusetts Institute of Technology; Dr. Stephan Timoshenko, head of the school of advanced mechanics at the University of Michigan; Dr. Edward Mack Jr., professor of physical chemistry, Ohio State university; Dr. P. W. Bridgman, head of the department of physics at Harvard university and Dr. C. E. Mendenhall, head of the department of physics at the University of Wisconsin. The first meeting was held recently with S. M. Kintner, director of Westinghouse research laboratories, at the East Pittsburgh plant.

* * *

Designs 100-Ton Metal Clad Airship

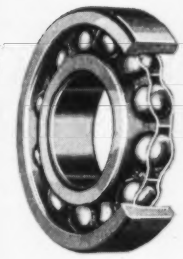
A 100-ton metal clad airship capable of a cruising speed of 100 miles an hour is being designed by the Detroit Aircraft Corp., Detroit. This announcement follows closely upon the successful trials of the first all-metal dirigible, the United States Navy ZMC-2. The new ship will be known as MC-38, will be approximately 250 feet long, 115 feet in diameter, equipped with 4800 horsepower, and will have sleeping accommodations for 50 passengers.

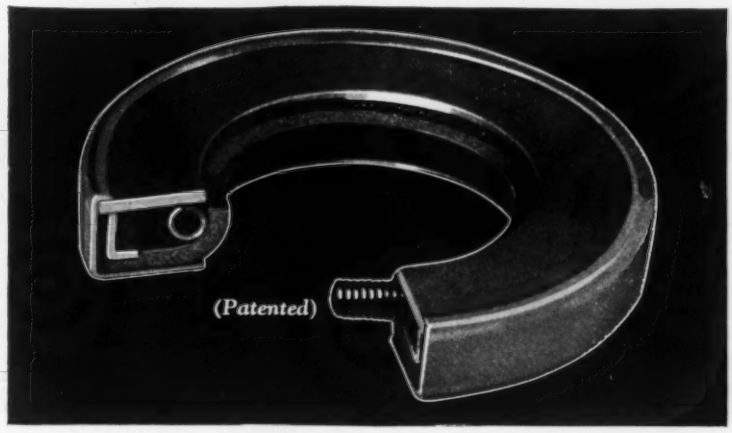
Metal construction permits a much larger internal gas pressure, more than five times that of the Shenandoah, eliminates absorption of water and consequent increased weight, reduces gas leakage to a minimum, considerably reduces danger from fire and defers deterioration of covering from the elements.

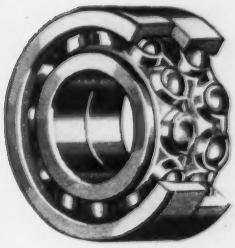
* * *

Engineers Appointed to Aid Museum

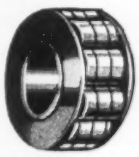
American Engineering council has appointed three engineering advisors to aid in the work of organizing the Industrial museum founded in Chicago by Julius Rosenwald. The appointees are M. E. Cooley, dean emeritus of the colleges of engineering and architecture, University of Michigan, Ann Arbor, Mich.; E. L. Ryerson, Joseph T. Ryerson & Son Inc., Chicago; and Joseph W. Roe, professor of industrial engineering, New York university, New York. These advisors are to help the museum interpret the evolution of science, engineering and industry.

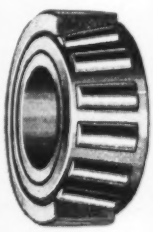






BEARINGS OF EVERY TYPE DESERVE THE PROTECTION OF THE PERFECT OIL RETAINER



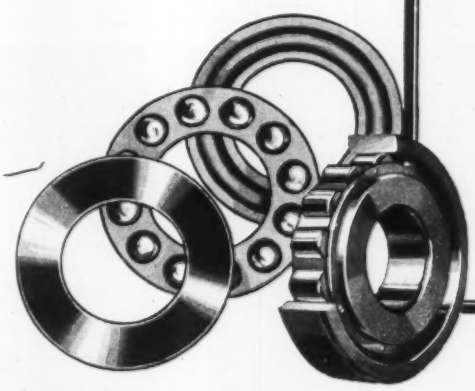


By preventing lubricant leakage and excluding moisture, dust, metal particles and abrasives the PERFECT OIL RETAINER maintains the high efficiency the bearing manufacturer builds into his product. ◆ ◆ ◆ Special tanning processes render the leather proof against the destructive influences of mineral lubricants and heat.

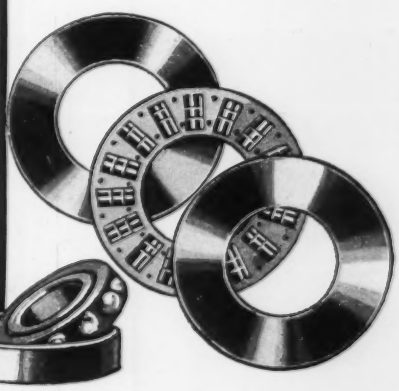
IF MADE OF LEATHER FOR MECHANICAL PURPOSES WE MAKE IT

The Chicago Rawhide Manufacturing Company

1304 ELSTON AVENUE, CHICAGO, ILL. BRANCHES: New York, Detroit, Cleveland, Philadelphia



Delivered as a compact, self-contained assembly consisting of leather packing member, spring and steel retainers — it offers the utmost in installation economy, lubricant-retaining efficiency and bearing protection.



NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

New Relay Is Vacuum Tube Device

INTERRUPTION of a beam of light controls the operation of industrial machinery and other devices by utilizing a new device, the photo-electric relay, announced by the General Electric Co., Schenectady, N. Y., as an addition to its standard line of control equipment. The new relay

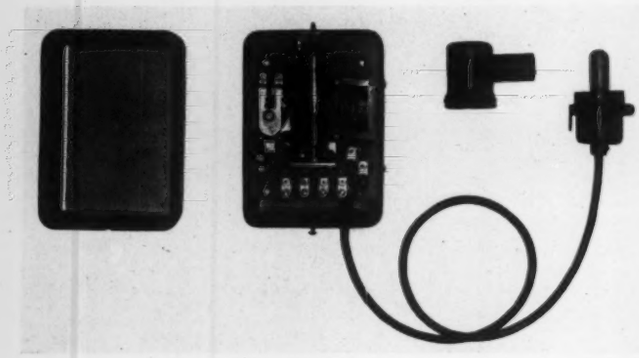


Photo-electric relay unit with covers removed to show tubes

is essentially a vacuum tube device, and uses both the photo-electric tube and the "pliotron."

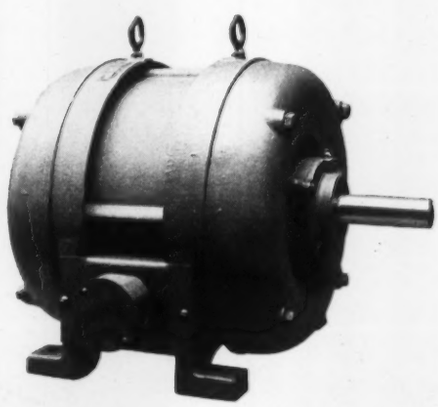
Many industrial or other operations in which a change of light is involved can be controlled by the new relay. In addition, many operations which can be arranged to cause a change of light can be so controlled. Standard electric supply for the relay is 110/120 volts, 60 cycles, alternating current. The device may, however, be built on demand for other frequencies or voltages, and a similar device for operation where only direct current is available can be obtained.

Operation of the relay is described technically as follows: With a voltage of proper polarity and magnitude applied between the two elements of the photo-electric tube, the current it passes is proportional to the amount of light shining on it. This current (of the order of a few micro-amperes) is amplified by a pliotron. The sensitive relay is connected in the plate circuit and is energized or de-energized in accordance with the amount of light on the photo-electric tube. The contacts of the relay control the coil circuit of the contactor. When the relay in the plate circuit of the amplifier is energized, it will first open its normally-closed contacts and then close the normally-open contacts. This relay, therefore, either makes or breaks the coil circuits of the contactor depending on how it is connected.

Redesigned Motor Has New Type Fan

CHANGING its former design and adding various improvements, the Cleveland Electric Motor Co., Cleveland, has developed a new line of motors which incorporate a redesign of the ventilating system, bearing brackets, fan and end rings. The new type of fan, according to the manufacturer, even at low speeds develops a steady pressure and volume of air, materially increasing the cooling effect as compared with the type formerly used.

Air is directed around the stator windings by baffles on the bearing brackets, and thence through unrestricted passages out through the end rings or castings that adjoin the laminations at each end of the stator. End rings are so designed that the air current leaves the motor in a practically horizontal direction, and passes over the outside face of the stator laminations, thus



Semi-enclosed, ventilated electric motor of new design has baffles to direct air around stator windings

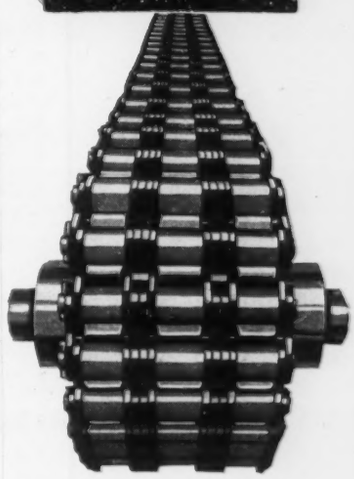
increasing the removal of heat. To give the motor the semi-enclosed feature, and to protect the air passages from dirt, the end rings are so con-

When transmission —"goes under the microscope"

SOONER or later, in every plant, trouble causes power transmission to be brought up for re-examination, study, test . . . and, if possible, correction. Usually the trouble is found to be the same: friction . . . responsible for power losses, scrapped equipment, repairs and maintenance expense, for delays and losses in production.

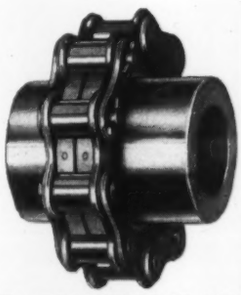
The closer you can get to friction-less transmission, the closer you are to trouble-free transmission. There are three great principles of anti-friction: rolling contacts; simplicity and ruggedness of design and fewness of parts; materials most resistant to wear used in construction. And the transmission which best embodies these three principles is apt to prove the best transmission for your purpose . . . the Diamond High-Speed Roller Chain.

ROLLING SURFACES DISCOURAGE WEAR



Every link in Diamond High-Speed Roller Chain is actually a roller bearing . . . rolling—not rubbing . . . to contact the sprocket tooth. Every link assembly in Diamond Roller Chain consists of but a roller, a bushing, a pin and two side plates. And since the roller's only function is to contact the sprocket tooth, it is made of the steel most resistant to wear. Since the only function of the connecting elements is to hold the rollers together, these parts are made of steels selected with respect to this one consideration.

And Diamond Chain provides along with this great durability and exceptional resistance to adverse conditions, many other advantages. It transmits 98-99% of power at 100% of speed . . . . up to 3600 R.P.M. Nor is there any "tapering off" in its efficiency; quality and quantity of your production remain the same, month in and month out.



The DIAMOND-CLARK
FLEXIBLE COUPLING

The Clark Flexible Coupling consists simply of two specially cut sprockets and a length of roller chain. It is made in a wide range of sizes for all ordinary load conditions, for shafts up to 11" in diameter. Its flexibility is in its design and not its material. It permits full freedom of alignment between couplings yet the two halves are held in positive driving connection. The simple, all-steel construction makes for long, trouble-free wear, ease of installation, disconnection and readjustment of drive relation. Complete information sent on request.

Diamond Chain is immediately available in single and multiple strands from ⅜" up to 2½" pitch. It is flexible, runs over and under sprockets, on multiple and long or short centers. It is extremely quiet.

Send for the descriptive booklet 102-A, "*Reducing the Cost of Power Transmission*", so that when power transmission troubles again come up you will know of an effective remedy. Use the handy coupon.

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue Indianapolis, Ind.
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DIAMOND CHAIN

ROLLING ~ AT POINTS OF CONTACT

(A-810)

structed that their outside flanges are carried out over the face of the laminations.

Magnetic hum, it is stated, has been eliminated. Motors in the new design are made as standard in squirrel cage and slip-ring types, both ball bearing and sleeve bearing, for general purpose, multi-speed or elevator applications.

Designs New Type Master Switch

TO REGULATE the control circuits of a magnetic contactor controller, the Electric Controller & Mfg. Co., Cleveland, has developed a new master switch for use on cranes, hoists, ore

Master switch is entirely enclosed by a cover of heavy gage steel

bridges, steel mill machinery, etc. Ball bearings are incorporated in the design and construction, and there is an accurately machined, notched track on which a roller-type centering device rides.

As shown in the accompanying illustration this master switch is entirely enclosed by a heavy gage steel cover and is arranged for conduit connection. Both the contacts and contact fingers are of improved design and easily renewable. Type NT master switches are built to give a maximum of six points of speed control in each direction with overload reset at the "off" position. Units for four, five and six points of speed control are identical, the only difference being the location of the arm stops.

New Metal Has Unusual Properties

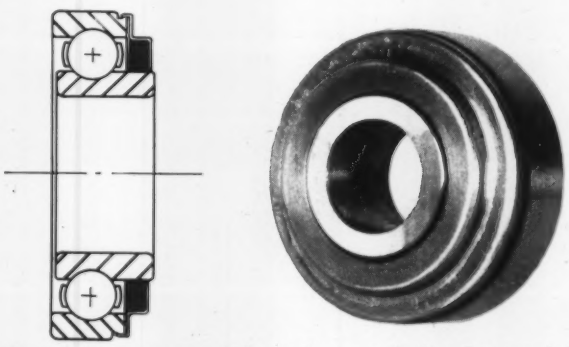
METAL known as "Perdit" iron now is being manufactured by the Davis & Thomas Co., Catasauqua, Pa., which holds a license from the German association controlling patents for making pearlitic cast iron. Using the so-called Emmel process which employes green sand molds and a 3 per cent total carbon, 2 per cent silicon mixture, this metal is found particularly suitable for automotive brake drums, sugar retorts, winch heads, clutch plates and machine frames. The "Lanz" process with a 3 per cent total carbon, 1.25 per cent silicon mixture for parts subject to heat is also reported to be successful in producing cylinder liners, grate bars and ingot molds.

A strength of 42,000 to 47,000 pounds per square inch is said to be shown by the castings obtained. A dense structure with a pearlitic matrix and a finely divided graphite distribution characterizes the castings. The cost of the iron by the Emmel process is said to be practically the same as for ordinary gray iron when steel scrap is used. No nickel or molybdenum are added, the tensile strength mentioned being solely the result of the melting technique.

Felt Seal Is Feature of Bearing

TO PROVIDE a closure of maximum effectiveness, the Fafnir Bearing Co., New Britain, Conn., has developed a J-type felt-seal bearing. A pressed steel shell is fitted permanently over one face of this bearing and shaped so as to contain a felt ring or washer. The bearing inner ring is wider than normal and thus allows the felt ring to bear closely on it, as shown in the accompanying illustration. This feature seals the bearing against dirt or escape of lubricant. The thin steel washer placed between bearing and felt holds the latter firmly in place against the outer shell and also aids in sealing.

While the felt seal is fitted closely around the inner ring, it is not so tight as to cause any fric-



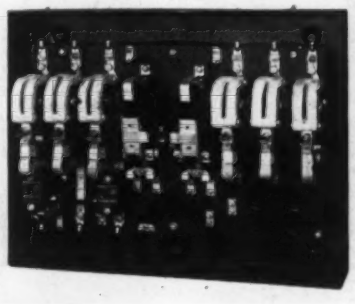
Sectional view of bearing at left shows felt seal fitted around inner ring. Mounting is shown at right

tional resistance. The steel outer shell, likewise, is fitted into a groove in the outer ring so that

there will be no interference with the ground surface of the outside diameter. Ten sizes of the felt-seal bearing now are available. These include the 30 series and smaller members of the 200 series, the suffix J being used after the bearing number as the designation for this type. Capacity is equivalent to that of the corresponding single row bearing.

Magnetic Switch Is Made Enclosed

THE ability to control motors of higher horsepower than those controlled by the superseded type is the principal advantage of a new enclosed,



Contactors are mounted side by side on a molded base. The enclosing case is of drawn-shell steel

magnetic, reversing switch announced by the General Electric Company. This switch, designated CR-7009-B-18, supersedes the CR-7009-B-5 switch of the same type.

The new device is designed to throw small alternating current motors directly across the line. It consists of two triple-pole, mechanically interlocked, magnetically operated contactors with restricted-type blowouts, and with a normally-open interlock on each contactor. It also has two hand-reset temperature overload relays. The contactors are mounted side by side on a molded base, instead of back to back as in the previous design. The device is contained in a drawn-shell steel enclosing case.

Maximum horsepower ratings of the new switch are as follows:

Volts	3- & 2-phase, 3- or 4-wire	Single-phase
110	7½	3
220	15	7½
440	15	10
550	15	10
600	15	10

Bearing Material Made Porous

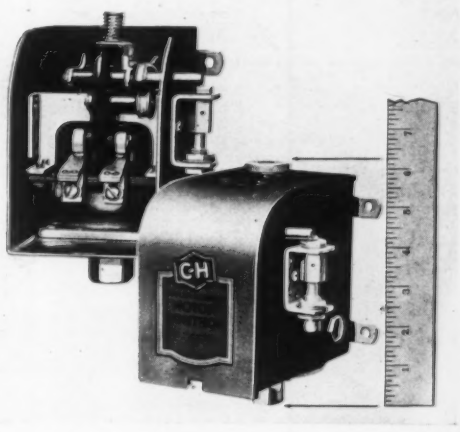
DUREX, a bronze of the copper-tin series and porous to about 25 per cent by volume, has been announced by the Moraine Products Co., subsidiary of General Motors Corp., Dayton, O. It was developed originally by the General Motors Research Corp.

In service Durex is impregnated with lubricant which is fed to the rubbing surface by capillary attraction and which provides a film separating the journal and bearing. Physical characteristics of the material are reflected in the low yield point in compression, which is about 4000 pounds per square inch; however, Durex bearings are operating satisfactorily with loads as high as 500 pounds per square inch.

It is claimed that the big advantage of this newly developed material lies in its ability to maintain a separating oil film when the machine is shut down. Most wear occurs, even in well designed machines, during the short interval after starting, following a period of rest.

Pressure Regulator Is Adjustable

EXCEPTIONALLY small in size, a new single pole pressure regulator has been announced by Cutler-Hammer Inc., Milwaukee. This new device, designated as Bulletin 10006, can be used as a starting switch for motors up to one horsepower, 230 volts, alternating or direct current, or as a pilot switch in the control circuit of automatic starters for larger motors. The regulator closes the circuit at low pressure and opens the circuit at high pressure. It can be adjusted to open circuit at pressure from 30 to 200 pounds.



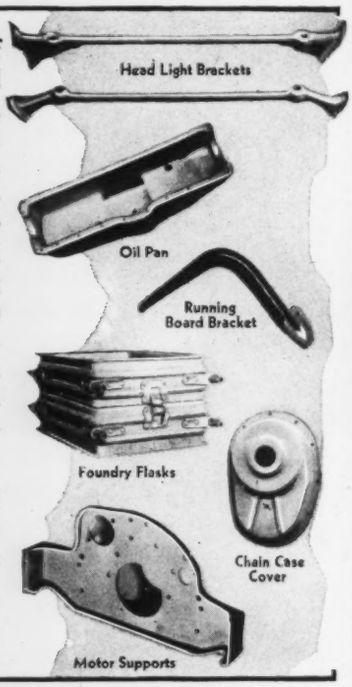
Single pole pressure regulator closes the circuit at low pressure and opens it at high pressure

Applications range over a wide field; the unit can be used for maintaining pressure on systems containing water, air, gas and other similar fluids. For air compressor service, a small unloader device at the side of the case removes the back pressure. To withstand moist atmospheres, the enclosing case is black japanned and metal work-

HEAVY PRESSED STEEL SECTIONS
in Large Quantities to the Most Exact Specifications

For the production of medium and heavy pressed steel sections, Truscon offers you an unusual service. All processes from initial design to complete assembly are under one supervision and responsibility, assuring prompt delivery. The greater accuracy and economy obtained through unit production result in better pressed steel products and lower costs.

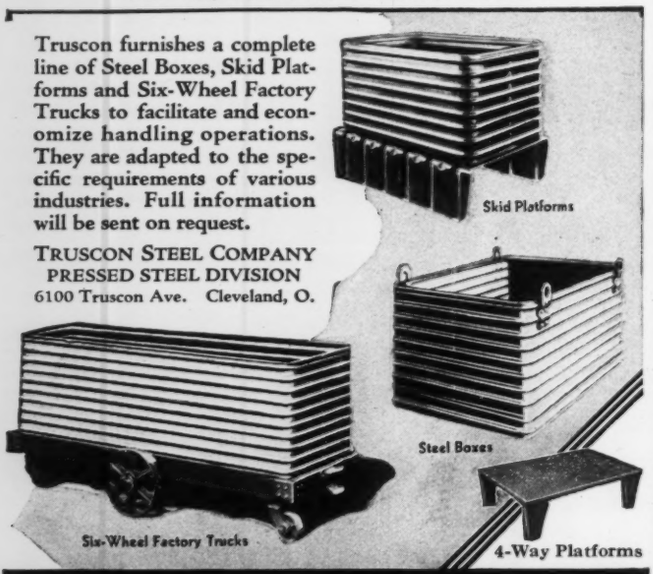
Manufacturers are urged to let Truscon Engineers cooperate with them in developing their products. Write for quotations on your pressed steel needs.



MATERIAL HANDLING EQUIPMENT
for Speed in Production

Truscon furnishes a complete line of Steel Boxes, Skid Platforms and Six-Wheel Factory Trucks to facilitate and economize handling operations. They are adapted to the specific requirements of various industries. Full information will be sent on request.

TRUSCON STEEL COMPANY
PRESSED STEEL DIVISION
6100 Truscon Ave. Cleveland, O.



SAVE WITH PRESSED STEEL

ing parts are cadmium plated. Double-break silver contacts, it is claimed, prevent pitting and insure good contact. The diaphragm is of rubber. Conduit knockout holes in the case facilitate wiring.

Develops New Photo-Electric Cell

A PHOTO-ELECTRIC cell with an amplifier now is sold as a unit by the Westinghouse Electric & Manufacturing Co., East Pittsburgh,

The amplifier unit consisting of a die-cast aluminum box in which all wiring is concealed. Connections are made to binding posts on top panel

Pa. The photo-electric cell, often called the "electric eye," is a light-sensitive device. When light falls upon it, voltage having been applied to the cathode, a current passes by means of electron emission from the cathode to the anode. This current is very small, but, when amplified, operates commercial relays.

For some applications, complete apparatus has been developed and can be supplied as a unit, but for most applications where no standard apparatus is available, the photo-electric cell with its amplifier is sold as a unit to be applied by the customer.

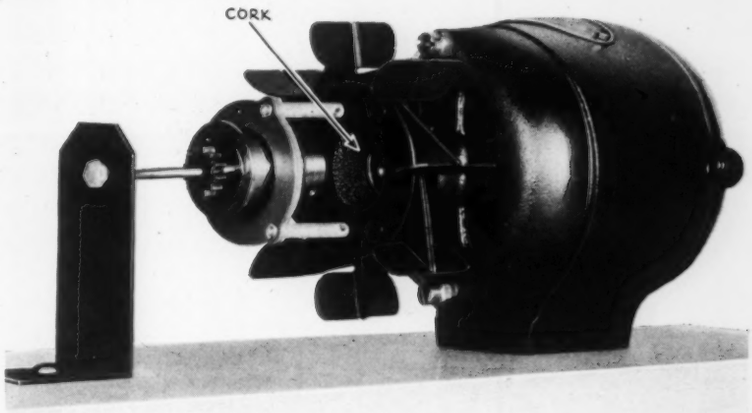
The amplifier unit, shown in the illustration, consists of a die-cast aluminum box in which are mounted the necessary coupling devices. The top, which is a Micarta panel, is provided with two four-prong bases for mounting the photo-electric cell and the amplifier tube. All of the wiring is concealed, connections being made to binding posts on the top panel. The unit is dust-proof and moisture-proof.

Clutch Has Carbon Steel Fingers

AN IMPROVED clutch known as the super-clutch has been introduced by the Carlyle Johnson Machine Co., Manchester, Conn. In place of the carbon steel forged clutch fingers or

Meet your friction service requirements with Armstrong's Cork

Even in oil or grease its frictional efficiency is not materially changed



FOR feeding, drafting, braking, driving, and other operations depending on friction, consider the exceptional qualities of Armstrong's Cork. Its gripping surface has found numerous applications in many types of machinery.

In addition to being frictionally efficient, Armstrong's Cork is compressible, resilient, and smooth surfaced. It grips the most delicate materials firmly but kindly.

For friction facings where there must be no slippage, where the releasing and picking up action must be positive and immediate, Armstrong's Cork can be used to advantage. It is not recommended where intentional slippage is desired.

Armstrong's Cork works to advantage in friction facings where there must be no slippage. An example of the use of Armstrong's Cork for this purpose is found in the motor and clutch assembly of the Eastman Kodascope projecting machine.

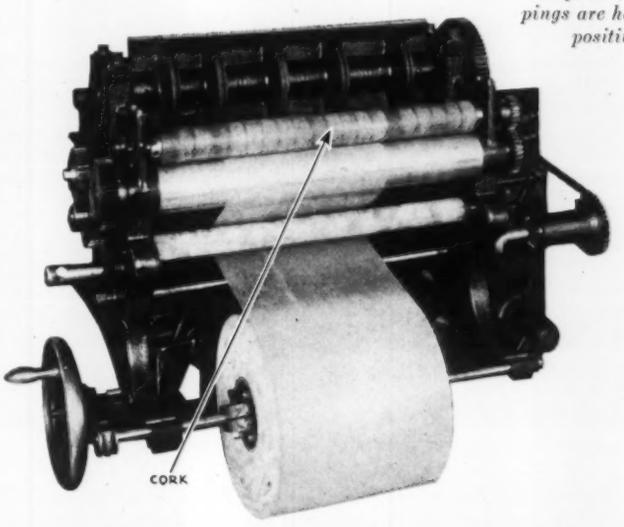
Armstrong's
(A)
Product

This gum wrapping machine, manufactured by the Battle Creek Wrapping Machine Company, employs Armstrong's Cork on the roll which measures and feeds the paper. Waxed paper, foil, Cellophane, and other wrappings are handled safely and positively by cork.

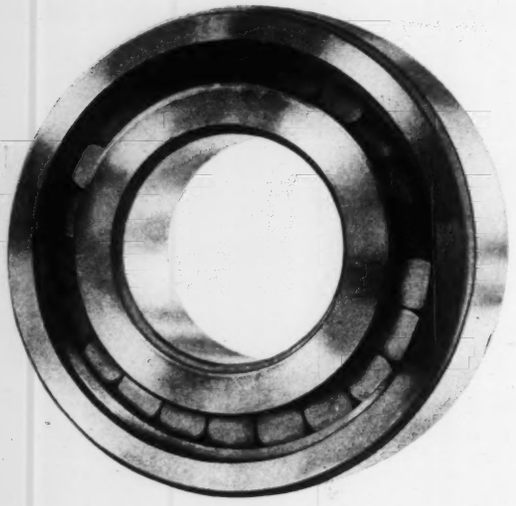
Cork, with its unique air-cell structure, retains abundant life and "come-back" under conditions that quickly cause other materials to take a permanent set. Oil and grease will not cause cork to deteriorate nor change its frictional efficiency to any appreciable extent.

In this and many other respects Armstrong's Cork stands alone. No other material combines to the same extent the qualities peculiar to cork—resistance to liquid penetration, low thermal conductivity, chemical inertness, stability, and light weight. Its low cost is also important.

Armstrong's Cork may be the solution to some of your difficulties. It can be shaped to your needs. Our Industrial Service Section offers you its help in working out your problems. Write Armstrong Cork Company, 918 Arch St., Lancaster, Pa.



Armstrong's
CORK
MADE TO YOUR SPECIFICATIONS



PROBLEMS

Solved From Experience

THEORY, imagination, inspiration—call it what you will—as used by the designing engineer, will be of no avail if specialized knowledge and experience are not used as a basis on which to build. Visualization is necessary to progress but fancy is no more important than fact. And it is in facts that we deal. We solve problems from experience.

Experience based on a knowledge of proved facts is the foundation of all progress. Nineteen years of engineering experience, with a thorough knowledge of the proper application of bearing principles, is the foundation on which Rollway *Cylindrical* Roller Bearings are built—the bearings of proved quality.

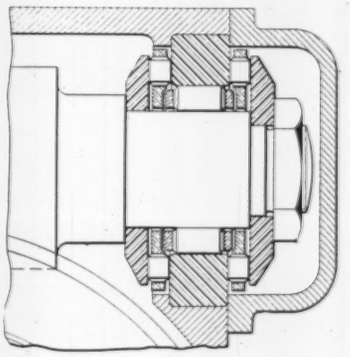
There is a proper solution to each of your bearing problems. Consult our engineers.

ROLLWAY BEARING
COMPANY INCORPORATED
SYRACUSE NEW YORK
ROLLWAY CYLINDRICAL ROLLER BEARINGS

toggle levers, the new super-clutch is equipped with chrome nickel steel fingers which are claimed to further increase the wearing qualities and reduce breakage to a minimum. The clutch also has been improved by installing a method of locking the adjusting screw, thereby holding the adjustment set by the operator. The adjusting screw cannot be loosened up by vibration, high speed or any other operating condition, it is claimed. Another improvement is the replacement of tool steel adjusting blocks with chrome nickel blocks. The Alemite system which provides one-point lubrication is a fourth improvement. This high pressure lubricating system forces grease to the interior of the mechanism and continuously lubricates all parts.

Bearing Takes Radial, Thrust Loads

DEVELOPMENT of a combined radial and thrust bearing recently was announced by Bantam Ball Bearing Co., South Bend, Ind. Ability of the bearing to take radial and thrust loads direct, and its extremely compact and rugged construction are noteworthy characteristics. This bearing, according to the manufacturers, replaces two of the regular type which require over twice the space. The accompanying illustration shows a sectional view of the unit. Races are designed so that the adjusting nut can be pulled up tight without the usual danger of locking the bearing.



A sectional view showing details of combined radial and end thrust bearing

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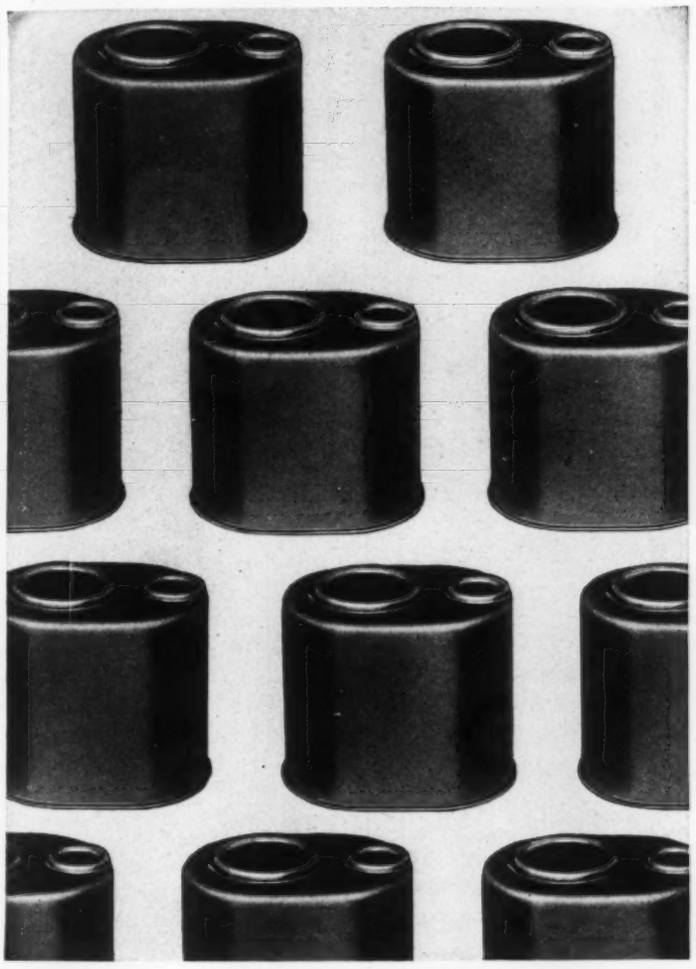
Outdoor Switch Has Drip Cover

OUTDOOR safety switch, type WK-55, designed to meet the outdoor requirements of railroads, mines, shipping yards, etc., has been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. It is similar to the standard WK-55 line, but it has the following additional features: A drip cover of special cadmium-plated steel is employed, which permits water to drip

Getting New or Improved Products to Market Ahead of Competition



Pressed steel body for automobile jack, produced by G. P. & F. at a 50% saving over cost of aluminum casting formerly used. Greater strength was also secured . . . chances of breakage eliminated

A Product on the Drawing Board Makes No Profit

IN designing new products or improving present models G. P. & F. pressed metal engineers can assist you, as they have thousands of other manufacturers eager to get modernized products on the market ahead of competition. During fifty years of experimental work in pressed metal fabrication these specialists have accumulated a vast and varied experience in metal forming and stamping. A suggestion from them may not only cut down your designing time, but also add materially to the appearance of your product.

G. P. & F. engineers can show you, as they have others, how to reduce rejections, increase strength, reduce breakage, speed up assembly and eliminate costly machining operations. The 19-acre G. P. & F. plant is equipped with ingenious equipment for the economical production of pressed and drawn products or parts in modern metals and finishes.

A blue print or sample part will bring recommendations and quotations promptly.

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Please send your 1930 Booklet, "In Harmony with Modern Progress," to the address below. It is understood the writer is not obligated.

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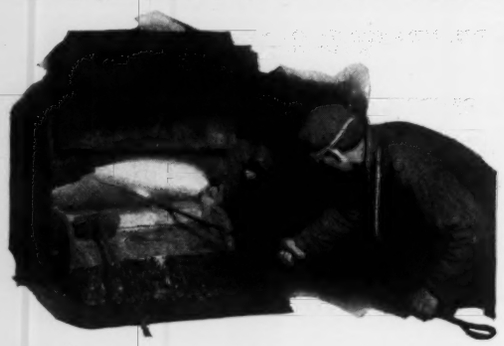
RARE METALS AND ALLOYS

TANTALUM · · · TUNGSTEN · · · MOLYBDENUM · · · CAESIUM · · · RUBIDIUM

FANSTEEL
for
Contact Points



Fansteel refines its own Tungsten
. . . *from the ore*

THERE is no "second best" in contact points. Either they are dependable, or they're not. And to assure dependability, it is necessary to begin by making metal *especially for contact points.*

In this, Fansteel is a pioneer. Selected Tungsten ore and Molybdenum salts are refined to 99.95% pure metal rods, which are carefully sawed into discs, thus presenting *end grain metal* as a contact surface.

These and the precise processes that follow are all carried on under one strict laboratory control with frequent inspections for *each contact point.*

If you're not already using them, give them a trial. There are numerous standard sizes to select from or the Fansteel laboratory will work with you in *designing* contact points especially for your requirements.

OTHER PRODUCTS

— Tantalum —

. . a Corrosion-proof metal . .

What couldn't you do with a metal that absolutely *cannot* be corroded by any acid except one. This metal is an element, Tantalum, now available in bars, rods, sheets, and wire. Easily worked and welded with ordinary tools, takes a beautiful finish. Costs only 1/12 as much as platinum. Get quotation on a *permanent* solution to your corrosion problem.

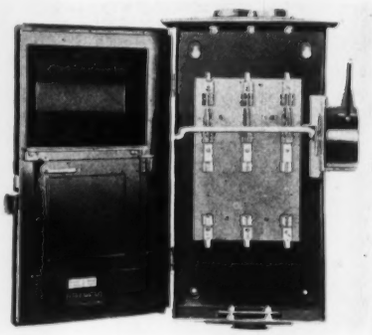
TANTALUM · · · TUNGSTEN · · · MOLYBDENUM · · · CAESIUM · · · RUBIDIUM

FANSTEEL PRODUCTS COMPANY, Inc.

NORTH CHICAGO, ILLINOIS

clear of the switch; cast iron cadmium-plated fittings are provided which together with gaskets are bolted to the drip cover and box; the top cast fitting has two threaded openings, and the bottom cast fitting has one threaded opening which insures a secure and water tight joint for conduit.

Cadmium plating to prevent rusting, is applied to the steel box, doors, handle assembly and all hardware. The base is made of ebony asbestos which has a high dielectric strength, is non-moisture absorbing and durable. All copper parts are tin-plated to prevent corrosion.



Interior of the outdoor safety switch provided with a cadmium-plated steel drip cover

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Introduces New Welding Electrode

A NEW electrode to be used for welding the commonly called "18-8 stainless steels," which will be known as "Stainweld A" has been announced by the Lincoln Electric Co., Cleveland. The advantages claimed by the manufacturer of the rod are that by its use, welds made can be of the same chemical content as the stainless steel itself, resulting in a dense ductile weld. This is accomplished by having the welding done in a protected atmosphere thus excluding the oxygen and eliminating oxidation of the weld metal.

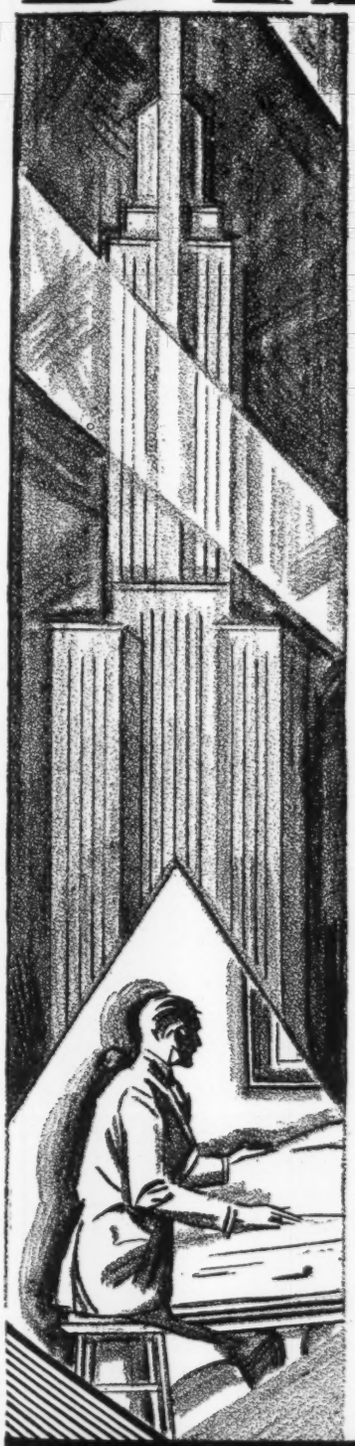
The rod itself is of the same chemical composition as the metal and is coated with a material which in the intense heat of welding forms a gaseous envelope around the arc. It is used with reversed polarity and permits the making of a weld that is just as impervious to corrosion as the metal it joins. "Stainweld A" is obtainable in three sizes 1/8, 5/32 and 3/16-inch, of the regulation 14-inch lengths, and can be used for horizontal, vertical or overhead welding.

Output of cars and trucks in the automobile producing countries of the world totaled 6,300,000 in 1929. Of this number approximately 85 per cent were manufactured in the United States.

Standardize on

DIETZGEN

DRAFTING & SURVEYING SUPPLIES



DIETZGEN today has a most complete and standard line of drafting and surveying instruments, supplies and furniture—superlative quality blue print paper to meet every requirement of architectural, professional, industrial or school drafting. The name DIETZGEN is a reliable guarantee of quality and satisfaction.

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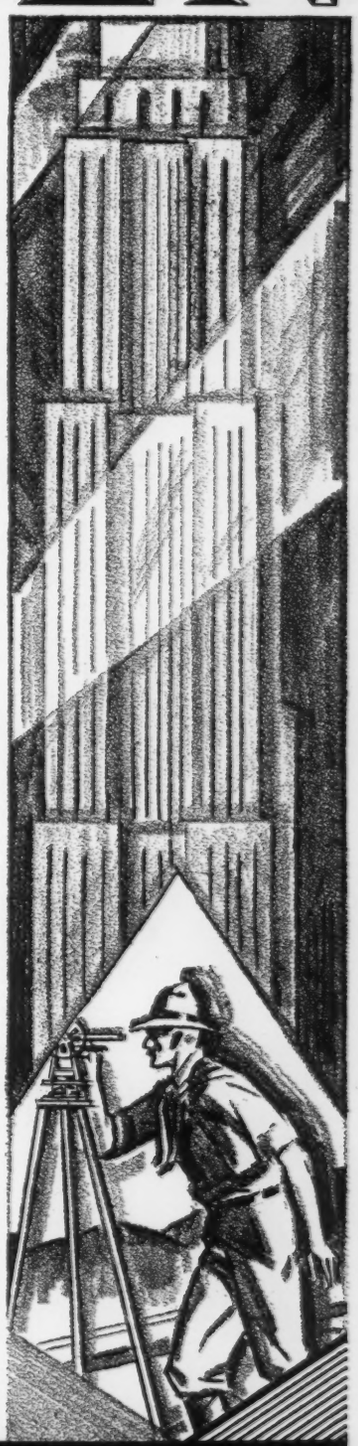

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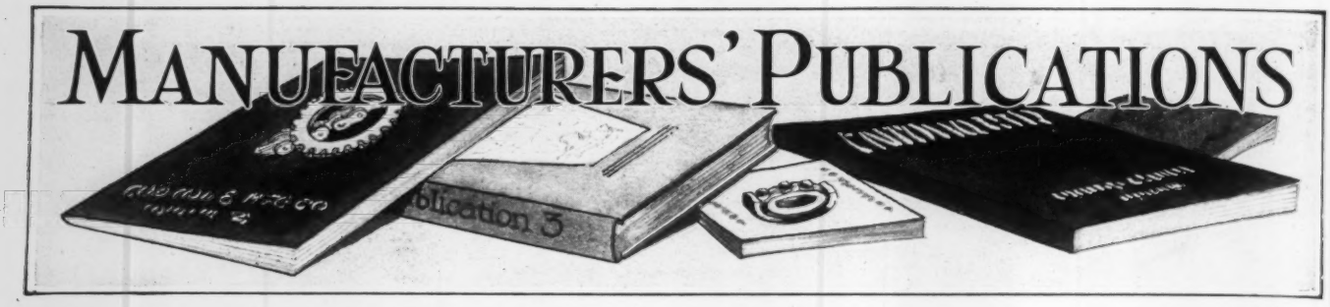

Publications listed in this section may be obtained without charge from the manufacturers of the products or through MACHINE DESIGN.

PUMPS—Ruthman Machinery Co., Cincinnati, recently issued a 40-page catalog covering its line of Gusher coolant pumps. Dimensional drawings and data tables supplemented by descriptions, offer the designer a comprehensive explanation of this company's product. The use of individual motors to drive the pumps is brought out in the description of this line of equipment.

STEEL CASTINGS—Commercial Steel Castings Co., Marion, O., subsidiary of the Osgood Co., has issued a bulletin on its open-hearth steel castings, illustrating a variety of product from large to small, indicating the range of work it is equipped to produce.

OIL CIRCUIT BREAKERS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has published a leaflet on a new weatherproof oil circut breaker rated at 400, 600 and 800 amperes, 1500 volts. The leaflet describes in detail the construction of the breaker, supplemented by photographic views. The breaker is made for manual solenoid, D. C. and A. C. rectox operations and these varioue operating mechanisms are described.

SWITCHES—Allen-Bradley Co., Milwaukee, describes in a current bulletin its line of starters for alternating current motors, each protected by an across-the-line switch designed for complete safety.

CLUTCHES—A 20-page catalog on Conway clutches recently was issued by Conway Clutch Co., Cincinnati. Descriptions, illustrations and data covering different types are given as helpful information to the designer and others interested in this equipment. Details of the different units are depicted by sectional drawings and parts going into their construction are shown. Dimension tables also are given.

NICKEL CAST IRON—International Nickel Co., Inc., New York, has prepared a booklet containing notes on uses of nickel cast iron. Applications are classified under five important industrial fields for ready reference by designing engineers or manufacturers of equipment employing cast iron. It is in handbook size for convenient use.

SPEED REGULATORS—Reeves Pulley Co., Columbus, Ind., has issued a leaflet on its variable speed transmissions, showing adaptation to various types of installation.

CASTINGS—"Some Facts about Heat and Abrasive Resisting Castings" is the title of a 22-page booklet recently issued by Jewell Steel & Malleable Co., 373 Hertel Avenue, Buffalo, N. Y. In addition to a short historical sketch of Jewell alloy, the booklet contains numerous illustrations of cast machine parts of interest to designers. Graphs and data tables also are given.

MOTORS—General Electric Co., Schenectady, N. Y., has issued a bulletin on its supersynchronous motors for large grinding and pulverizing mills, affording maximum torque available for controlled slow starting. The bulletin is illustrated by halftones of numerous installations of this class of motor.

LUBRICATION—E. F. Houghton & Co., Philadelphia, has issued an illustrated leaflet calling attention to one type of its lubricating oils especially suited to problems encountered in lubrication of modern machinery.

INGOT IRON—American Rolling Mill Co., Middletown, O., has prepared a booklet on savings in the oil industry made possible by use of its ingot iron to resist corrosion. Reference data are included.

ISOLATION—Korfund Co. Inc., New York, devotes the current issue of its publication on isolation to discussion

(*Concluded on Page* 78)

AUBURN LONG-LIFE BEARINGS

When designing machinery for continuous service, the long life of Auburn Bearings merits your consideration.

Thrust Ball Bearings—Built like a Speedway—and Annular Ball Bearings—With Heavy Bronze Anti-Friction Retainers—are manufactured in a wide variety of types and sizes to meet many conditions of service. Let us assist you. Bulletins and data sheets upon request.

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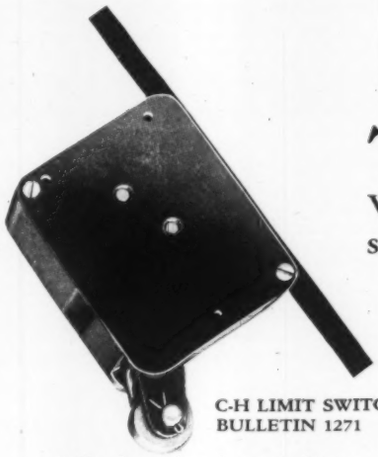
Limit Switches which co-operate with Motor Control



C-H LIMIT SWITCHES
BULLETIN 1271

1. Can be used on doors, machines, conveyors, etc. 2. Push-button, roller-lever or gravity operation. 3. Right or left-hand mounting; normally open or normally closed contacts, for wide variety of uses. 4. Rugged construction for long service. 5. Easily renewable contacts. 6. Dust-proof case. 7. Double-break protection against shorts, etc. 8. Up to 600 volts capacity.

THE dependable operation of Motor Control in many cases depends upon the control-accessories. So does production. With the failure of *one* limit switch, your processes can be snarled up . . . halted . . . the value of an investment of thousands of dollars impaired. Therefore, when you select limit switches make your choice with the utmost care . . . make sure that these accessories actually help your control perform its duty.

The Cutler-Hammer Line of Limit Switches has been designed and built with full realization of the responsibilities placed upon this equipment. They are the fruits of 30 years' intimate contact with the needs of American Industry . . . the fruits of 30 years' experience in the electrical control field. They are built to the highest standards of ruggedness, durability and performance. You are invited to investigate this line carefully . . . and to see how you and your production can depend on it . . . for all time. A letter will bring you further information.

C-H LEVER-OPERATED
MASTER SWITCH
BULLETIN 10252

1. Low voltage protection. 2. Wide clearance between live parts. 3. Non-stubbing contacts. 4. Extra long bronze bearings with convenient oil holes—low maintenance. 5. Simple, rugged construction. 6. Square operating lever shaft—four mounting positions—added adaptability. 7. Completely enclosed extra heavy case for safety. Cover easily removed.

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Pioneer Manufacturers of Electric Control Apparatus
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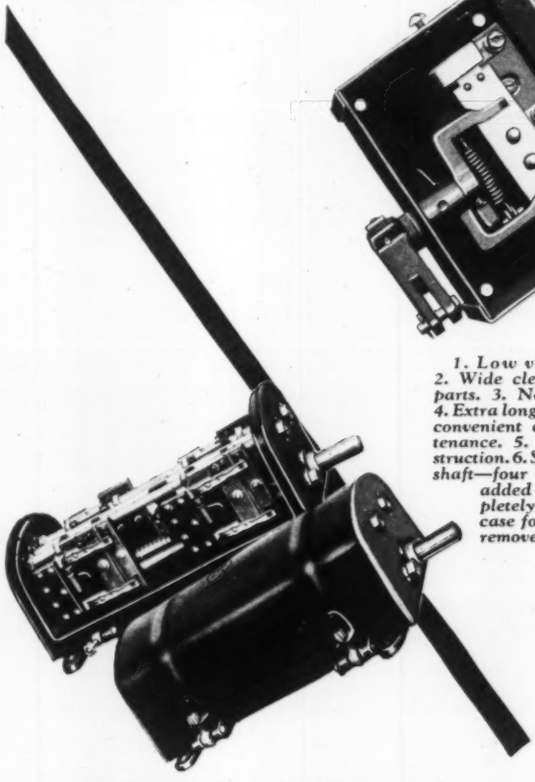

C-H TRAVELING CAM LIMIT SWITCH
BULLETIN 14952

1. Wide range of adjustment, extreme accuracy in stopping. 2. Double-pole contacts prevent accidental grounds or shorts. 3. Contacts, quick break type; when adjusted to the tripping point can be positively locked to that position. 4. Rugged construction throughout. Bearings bronze-bushed. Dust-proof cover. 5. Contacts and fingers are standard C-H construction.

C-H CRANE SAFETY LIMIT SWITCH
BULLETIN 10111

1. Compact size—mounting in 4 positions. Easily wired. 2. No pilot circuit required. 3. Dynamic braking, quick positive stopping. 4. Quick acting contacts—automatic reset. Contacts and shields easily renewable—interchangeable with standard mill type contactor parts. 5. Rugged construction throughout. 6. Tripping weight an integral part of switch. 7. Built in two sizes.

CUTLER HAMMER

The Control Equipment Good Electric Motors Deserve

(A-284)

Concluded from Page 76)

of its methods of eliminating transmission of vibration to the framework of machne structures by use of cork mats.

LUBRICATION—Alemite Lubricator Co., Chicago, calls attention in a current bulletin to its method of industrial lubrication, to conserve power otherwise lost through friction.

PUMPS—Chicago Pump Co., Chicago, recently issued a 20-page bulletin designated No. 111 covering its pumping equipment designed for pneumatic installation. Engineering tables and specifications supplement the text and illustrations.

SAFETY SWITCHES—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes in a new catalog its line of safety switches. Illustrations, data and descriptions of construction and operation cover the entire line. Some new switches are introduced in this catalog.

NICKEL STEEL—International Nickel Co. Inc., New York, is distributing two bulletins, one dealing with nickel-chromium steels for high temperature service in valves and bolts, and the other with approximate relations between hardness and tensile strength of alloy steels. Charts and tables serve as illustrations.

ALUMINUM ALLOYS—Aluminum Co. of America, Pittsburgh, has issued a booklet on its aluminum casting alloys, uses and advantages. It considers hardeners and their effects, standard alloys, general foundry principles and physical data.

IRON PLATES—Pure iron plates for long service is the subject of a bulletin by the American Rolling Mill Co., Middletown, O. The distinction is drawn between the characteristics of steel and iron, their resistance to corrosion, their weldability and uses to which each is suited. Illustrations show tests applied to iron plates.

FORGINGS—National Machinery Co.. Tiffin, O., has issued a bulletin to illustrate the variety of machine parts which can be forged with economy and gain in strength. The group is taken from products of a concern using forging machines made by the National company.

STEELS—Ludlum Steel Co., Watervliet, N. Y., has issued two booklets, one a 24-page catalog and the other a reference book of steel treating tabulations. The catalog contains complete information on Ludlum steel which includes high-speed carbon and alloy tool steel, corrosion, heat and wear resisting steels, valve steel and Strauss metal. These publications are replete with much helpful information for the designer.

STRENGTH + ENDURANCE + COMPACTNESS

The JANETTE Speed Reducer

Builders of small slow speed motor-driven apparatus will find in the JANETTE Speed Reducer the solution to their problems of efficient drive. This unit embodies in a high degree the characteristics of *strength, endurance and compactness* required by such manufacturers.

The JANETTE Speed Reducer comprises a motor and speed reducer in one compact and completely assembled unit. Equipped with sturdy JANETTE *Ball-Bearing* Motor, steel worm, and bronze gears. Gears run in a bath of oil.

Available in sizes from 1/30 to 1/3 H.P. and with reductions ranging from 20-to-1 to 70-to-1. Write for Bulletin SR-529.

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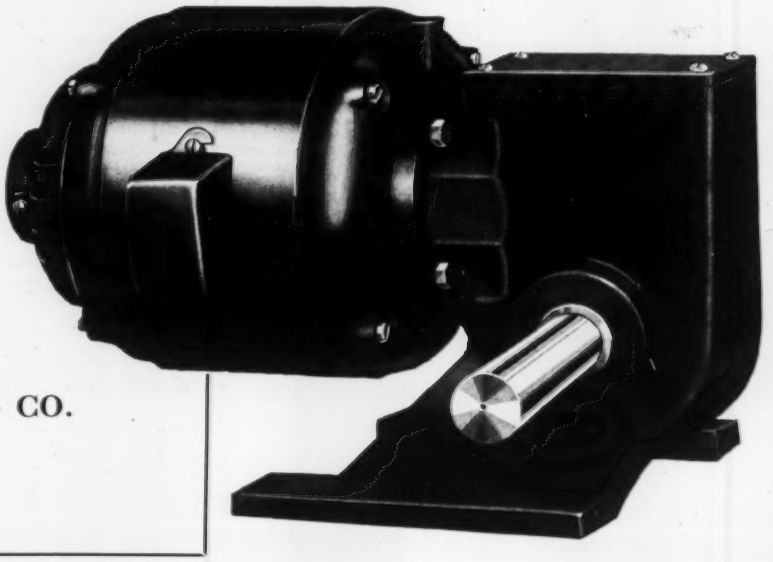
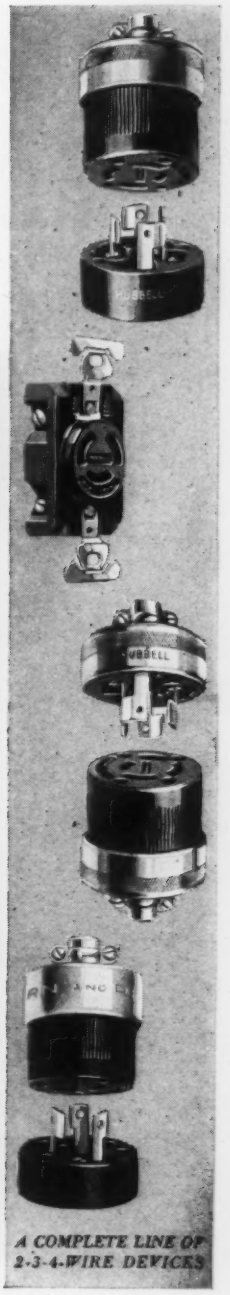
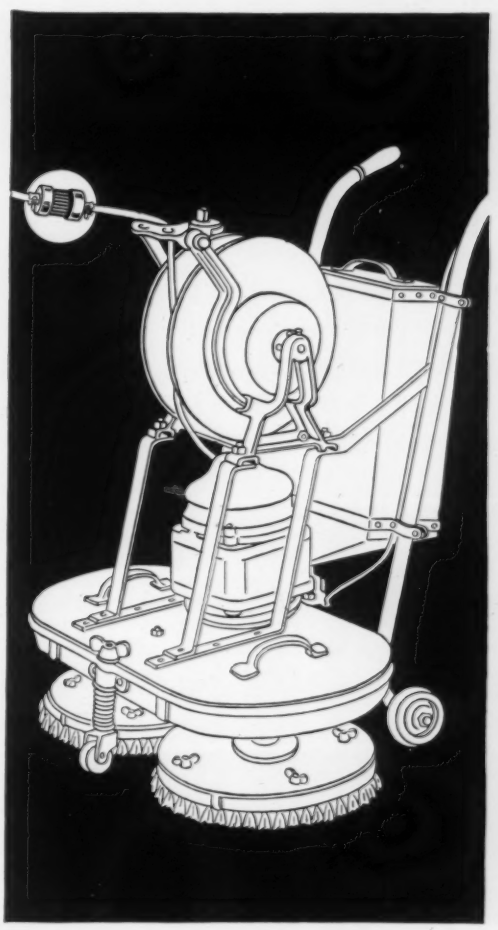
JANETTE Type "RW" Speed Reducer. Note solid, well-built appearance.



Twist-Lock Devices

"help keep our machines ahead of competition"





"Their advantages appeal to every owner of our machines"

These statements made by a famous maker of floor machinery will be quickly seconded by scores of manufacturers of electrically operated and motor-driven machines. Twist-Lock Devices have provided many machines with added sales features of real importance.

Twist-Locks *combine the convenience of a separable connection with the security of a direct connection.* They offer decided advantages over both.

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Used instead of a standard separable connection, as on the scrubbing machine illustrated, a Twist-Lock Device banishes disconnection trouble. It will not part accidentally. Three and four-wire Twist-Locks provide for proper grounding, too, which protects the operator of the machine against electrical hazard.

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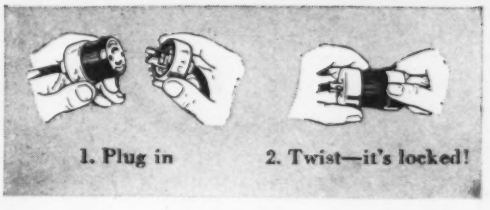

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